FINAL

# Faro Water Treatment Plant Sludge Characterization Report

Faro Mine, Yukon Territory

Crown-Indigenous Relations and Northern Affairs Canada

SRK Consulting (Canada) Inc. ▪ 1CA030.025 ▪ July 2021

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Faro Mine, Yukon Territory

**Prepared for:**
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# Useful Definitions

This list contains definitions of symbols, units, abbreviations, and terminology that may be unfamiliar to the reader.

| | |
|---|---|
| ARD | Acid rock drainage |
| AWT | Applied Water Treatment |
| DO | Dissolved oxygen |
| DOC | Dissolved organic carbon |
| EC | Electrical conductivity |
| EDS | Electron Dispersive Spectrometry |
| Global ARD | Global ARD Testing Services Inc. |
| HDS | High-density sludge |
| mg/kg | Milligrams per kilogram |
| mg/L | Milligrams per litre |
| ORP | Oxidation reduction potential |
| PWTP | Permanent Water Treatment Plant |
| QA | Quality assurance |
| QC | Quality control |
| SEM | Scanning Electron Microscope |
| SFE | Shake-flask extraction |
| TDS | Total dissolved solids |
| TOC | Total organic carbon |
| TSS | Total suspended solids |
| Wt% | Weight percent |

# 1 Introduction and Scope

SRK Consulting (Canada) Inc. has been retained by Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC) to advance closure and remediation plans for the Faro lead-zinc mine, located in the central Yukon 200 km north-northeast of Whitehorse. Part of the overall remediation plan for the Faro Mine involves construction of a mine water capture and conveyance system and a Permanent Water Treatment Plant (PWTP). The Permanent Water Treatment Plant will use a high-density sludge (HDS) process which neutralizes acidic contact water and removes dissolved metals and other constituents. Sludge produced by the treatment process will be pumped to the bottom of Faro Pit Lake for permanent storage and disposal.

Over time, the Faro Pit Lake is expected to become acidic as acid-rock drainage (ARD) continues to develop in waste rock and tailings. The pit lake may also develop reducing conditions. Both acidic and reducing conditions could affect the long-term stability of the sludges, potentially contributing chemical loads of some constituents to the pit lake. As the pit lake will act as the main reservoir for storage of contact water and will be the main feed to the Permanent Water Treatment Plant, the chemical stability of the sludge within the Faro Pit Lake is an important consideration for water management at the site.

To understand the implications of sludge disposal within the Faro Pit Lake, SRK conducted a geochemical characterization program on water treatment sludges collected as part of a 2017 pilot plant testing program. The characterization program aimed to meet the following:

- Characterize the basic physical, geochemical and mineralogical properties of the sludge;
- Quantify loading of readily soluble constituents within sludge under neutral and acidic conditions; and
- Test solid-phase associations of parameters of concern and the potential for leaching of these under variable environmental conditions.

This report documents the results of the geochemical sludge testing program.

# 2 Background

## 2.1 Faro Pit Lake

### 2.1.1 Basic Overview of Pit Lake Limnology

The limnology within the Faro Pit Lake will influence sludge storage conditions at depth within the pit. The following summarized from Pieters and Lawrence (2016) provides a general overview of pit lake limnology – and more specifically stratification within pit lakes.

The behavior of pit lakes is a result of interactions between physical and chemical processes. Stratification, or the development of stable layers with varying physical and chemical characteristics is the most important physical process within pit lakes.

Most lakes in Canada stratify during summer months due to development of a thermocline. Heating of the near-surface water reduces its density, leading to development of stratification, with the upper less dense warm layer isolated from the lower more dense, cooler layer. In late summer or autumn, cooling of the upper layer usually leads to the two layers reaching a similar density. As the density contrast decreases to near parity, winds overturn the layering, resulting in mixing of the lake.

In pit lakes, other factors can lead to a possibility that the layering will persist year-round. Pit lakes are generally much deeper and have less surface area than natural lakes. These geometric factors tend to reduce the ability of winds to mix the lake. Another factor is chemistry. Water in pit lakes can have high TDS (i.e. >4,000 mg/L) which can affect the water's density. If the dissolved solids become concentrated in the lower portion of the lake, or if the upper layer becomes diluted by precipitation or surface runoff, a density gradient known as a "chemocline" can develop. Since the chemocline is unaffected by the late season cooling of the upper water, it has the potential to create year-round stratification.

"Meromixis" is as the limnological term for the condition were a lake is permanently stratified due to development of a chemocline. A condition of meromixis in the Faro Pit Lake would have significant implications for pit lake water quality, as it could create gradients in TDS, pH, and Eh with depth and promote the development of reducing (low Eh) conditions within the lower portion of the lake.

### 2.1.2 Faro Pit Lake Geochemistry

Current and future water quality within the pit lake is expected to influence sludge stability both as a result of direct chemical interactions and through indirect effects related to the limnology.

The Faro Pit Lake has been periodically profiled for conductivity, temperature, and water quality parameters since 2004, and regularly profiled since 2014. This work has identified that the pit lake exhibited salinity stratification during from 2004 to 2008 as freshwater was added to the lake surface and contact water with high TDS concentrations was pumped into the lake at depth. The salinity stratification slowly declined from 2009 to 2012 when the contact water with high TDS water was rerouted to the pit lake surface. 2007 and 2008 water quality profiling conducted when the salinity stratification was at its peak showed that pit lake water at depths greater than 30 m had Eh values that ranged from 0.19 to 0.28 V, indicative of anoxic and moderately reducing waters that fall in the range of the redox ladder where nitrate and $Mn^{4+}$ reduction occurs. Since 2008, continued discharge of mine contact waters to the surface of the lake has prevented salinity stratification from developing. pH conditions in the pit lake have remained neutral through 2020, but sulphate and metal concentrations have increased (SRK 2020).

Over time, as further development of ARD occurs in the waste rock and tailings, acidic pH conditions and increased concentrations of sulphate and metals are expected to develop within the pit lake. The predicted base case pit lake chemistry following complete onset of ARD based on the site wide water and load balance model (SRK 2019a) is summarized as follows:

- 1,200 to 2,700 mg/L $SO_4$
- 60 to 80 mg/L Ca
- 0.05 to 0.08 mg/L Cd
- 0.04 to 0.1 mg/L Co
- 0.5 to 1 mg/L Cu
- 50 to 1,000 mg/L Fe
- 80 to 100 mg/L Mg
- 16 to 19 mg/L Mn
- 0.05 to 0.25 mg/L Ni
- 60 to 180 mg/L Zn

SRK are currently evaluating whether different management approaches such as discharge of high TDS mine waters at depth or a one-time placement of a freshwater cap could be used to re-establish meromictic conditions within the pit lake. If this occurs, anoxic and slightly reducing to reducing conditions will likely develop at the bottom of the lake.

## 2.2 Treatment Process and Sludge Generation

The treatment process for Long-term Operations and Maintenance of the Faro Mine Site was selected to be High Density Sludge (HDS) lime neutralization. The HDS treatment process involves a three-step treatment process that involves:

1. Mixture of hydrated lime with sludge in a mix tank;
2. Reaction of lime/sludge mixture with contact water in an aerated reactor tank with a target pH endpoint of pH 9.6; and
3. Addition of flocculent in a clarifier to achieve separation of treated water and sludge; with some sludge being recycled back into the system.

The HDS process is effective at the removal of pH sensitive metals, acidity and sulphate (if concentrations are above gypsum saturation) through the precipitation of mixed metal hydroxides and gypsum.

Applied Water Treatment (AWT) conducted pilot plant testing of an HDS treatment system using a mixture of pit water and waste rock runoff that was targeted to be similar to predicted pit water concentrations during the Long-term Operations and Maintenance (AWT 2018). The pilot plant testing was carried out from August $15^{th}$ to $29^{th}$, 2017 and produced sludge with a density of 19 to 24.7% solids, with the solid content of the sludge in the clarifier increasing through the duration of testing. The pilot tests included variations in reaction times, sludge recycle rates, and pH endpoints (ranging from 8.9 to 9.9). The density of sludge from the full-scale PWTP is expected to be 15 to 25% solids.

## 2.3 Sludge Storage

The current plan is for sludge produced by the treatment process to be pumped from the PWTP to the bottom of Faro Pit Lake for permanent disposal (SRK 2018). Two sludge pipelines (one spare) will transport the sludge from the WTP to Faro Pit. Based on an estimate of the storage capacity of the Faro Pit Lake, the pit lake has enough storage for >1,000 years of sludge deposition.

# 3 CGM and Program Design

## 3.1 Conceptual Geochemical Model (CGM) for Sludge Stability

### 3.1.1 Interaction of Sludge with Pit Lake Water

The Faro Pit Lake was selected as a disposal location for the treatment sludges due to the high storage capacity of the pit lake and the expected geochemical stability of the sludges under saturated conditions.

The current plan is to dispose the treatment sludges at the bottom of the pit lake via tremie lines. Following deposition, the sludges are expected settle and compact forming a layer of sludge at the base of the pit lake. Interactions between the sludge and pit lake water will therefore be limited to:

- Sludge particles which stay in suspension within the pit lake water column prior to settling;
- The interface between the sludge layer and the pit lake water; and
- Pit lake water which moves through the sludge layer following hydraulic and diffusive gradients.

Within the pore spaces of the sludge layer, excess hydroxide alkalinity will likely result in buffering of sludge porewaters to neutral to slightly alkaline conditions under which the sulphate and hydroxide minerals within the sludges are expected to be chemically stable. Interactions at the sludge/pit water interface and between sludge particles in suspension and the water column will likely therefore contribute the greatest loadings to the pit lake water column.

### 3.1.2 Stability Under Acidic and Reducing Conditions

Where interactions between sludge and pit lake water occur, at the surface of the sludge layer and in the pit lake water column prior to settling, the surface of the sludges is expected to be exposed to neutral to acidic, high total dissolved solids (TDS), and potentially reducing conditions in the pit lake water. Given the current understanding of the sludge's composition, the greatest risks to sludge stability are considered to be:

- Interaction of suspended sludge particles and the surface of the sludge layer with acidic pH which could cause:
  - Dissolution of hydroxide precipitates by reaction 1:

    1) $(Fe, Mn, Zn, Ni, Cd)(OH)_2 + 2H^+ \rightarrow (Fe, Mn, Zn, Ni, Cd)^{2+} + 2H_2O$

  - Release of anions or cations that are sorbed to the hydroxide precipitates.
  - Sorption of anions and cations to remaining hydroxide precipitates.
  - Desorption of cations from hydroxide precipitates.
  - Buffering of pH.

- Development of reducing conditions which could cause reductive dissolution of $Fe^{3+}$ and $Mn^{3+}$ oxides and hydroxides and subsequent release of Zn, Ni, Cd and other co-precipitates or sorbed species.

The long-term chemical stability of the sludge is therefore expected to be controlled by the sludge's stability under acidic and slightly reducing conditions.

### 3.1.3 Impact of Sludge Disposal on Pit Lake Water Quality

The main implications of sludge disposal within the Faro Pit Lake for pit lake water quality are considered to be:

- Release of dissolved constituent concentrations; and
- Buffering of acidity within the pit lake by alkalinity stored within the sludge and sludge porewaters.

The sludges likely contain at least several percent gypsum and if sulphate and calcium concentrations in the pit lake area below saturation, the sludge would be expected to contribute sulphate and calcium loadings to the pit lake. Loadings of the water-soluble fraction of other elements could also be possible and these need to be quantified.

Although the rate of sludge inflow will be small compared to the total volume of the pit lake (ratio of yearly inflow to total volume = 0.0008), the alkalinity stored within the sludges may have the potential to buffer the pH of the pit lake. The majority of the alkalinity contained in the sludge is expected to be stored as hydroxide alkalinity. If these hydroxide phases re-dissolve by reaction 1 or reaction 2 shown below they would consume acidity or release their hydroxide alkalinity back to the water column:

2) Fe, Mn, Zn, Ni, Cd $(OH)_x \rightarrow (Fe, Mn, Zn, Ni, Cd)^{2+} + xOH^-$

Additional buffering capacity is also expected to be present within other neutralizing mineral phases within the sludges such as carbonates and as bicarbonate and hydroxide alkalinity within the sludge porewaters. Incorporation of these buffering effects can therefore be assessed by quantifying the buffering capacity of the sludge and the sludge porewaters.

## 3.2 Program Design Rationale

Following development of the CGMs, a laboratory geochemical testing program was designed to fill the gaps in understanding the physical and chemical characteristics of the WTP sludges and their geochemical stability under the range of expected disposal conditions. The information gaps and corresponding characterization procedures are summarized in Table 3-1.

**Table 3-1: Program Design Rationale**

| Data Gap | Component | Characterization Program |
|---|---|---|
| Physical Characteristics | Solids content and particle size distribution | Measurement of physical characteristics |
| Mineralogy | Mineralogy of sludge | Characterization of sludge mineralogy by scanning electron microscope (SEM) automated mineralogy and electron dispersive spectrometry (EDS) spot analysis to determine chemistry of unknown mineral phases |
| Chemical Characteristics | Elemental content of sludge | Analysis of sludge elemental content following aqua regia and whole rock digestion |
| | Buffering capacity of sludge | Titration of sludge to measure buffering capacity |
| Chemical Stability Under Disposal Conditions | Water soluble fraction under neutral and acidic conditions | Customized shake-flask extractions conducted for range of pH conditions using de-ionized water and pit lake water |
| | Long term stability under range of pH and Eh conditions | Aging tests performed under varying combinations of neutral, acidic, oxic, and anoxic conditions using de-ionized water and pit lake water |
| | Speciation of major and trace elements amongst chemical and mineralogical forms within sludge | Interpretation of mineralogy data and customized sequential extraction procedure |

Source: Z:\01_SITES\Faro\!101_Investigations\2020_WTP_SludgeCharacterization\4. Report\[ProgramDesignRationale_1CA030.025_JED_Rev00.xlsx]

# 4 Methods

## 4.1 Sample Collection

### 4.1.1 Sludge Sample Collection, Storage and Preparation

Sludge samples were obtained from the 2017 HDS pilot plant testing program completed by AWT (2018). At the completion of the pilot plant testing program, SRK Engineer Marie-Christine Noel transferred the sludge within the pilot plant clarifier to five twenty-liter screw top buckets with sealable lids. The sludge was then stored in the SRK Vancouver office at room temperature until March 2020 when this program was initiated.

In March 2020 the sludge was transported to Global ARD Testing Services Inc. (Global ARD) in Burnaby, BC for sample preparation and testing. Following storage, the sludges remained fully saturated and remained the same color as when collected (pers comm. with AWT) with no visibly detectable signs of oxidation or chemical alteration. Photos of the sludge in each bucket following storage are shown in Table 4-1.

**Table 4-1: Pictures of WTP Sludge Following Storage**

**Bucket #1**

**Bucket #2**

**Bucket #3**

**Bucket #4**

**Bucket #5**

Prior to removing aliquots of sludge for each test, buckets 1, 3, and 5 were combined and homogenized to create one master sample that represented the contents of the clarifier at the end of the pilot plant commissioning work. Buckets 2 and 4 were retained for future testing. Following homogenization, aliquots were removed for particle size distribution and solids content. The sludge sample was then vacuum filtered using filter papers with a particle retention of >25 µm. After filtering, aliquots of filtered solids were removed for aging tests and sequential extractions, and the filtrate was submitted for analysis. The remaining filtered solids were then oven-dried at low temperature (<40 °C) with aliquots of dried sludge removed for shake-flask extractions, elemental and mineralogical analysis.

### 4.1.2 Pit Lake Water Sample Collection

In order to simulate interaction of the WTP sludge with both non-acidic and acidic pit lake water, water samples were collected from the Faro Pit Lake and the nearby Vangorda Pit Lake which had already developed acidic conditions and is expected to be analogous to future conditions within the Faro Pit Lake.

Water samples were collected from the Faro Pit Lake and the Vangorda Pit Lake by SRK water resources engineer Mark Sumka (EIT, BC) on March 17 and 18, 2020. At the Vangorda Pit Lake, a 20 L unfiltered and unpreserved water sample was collected from the bottom of the pit lake at 40 m depth using a Van Dorn sampler. Access to the Faro Pit Lake was restricted for safety reasons and a 20 L unfiltered and unpreserved sample was collected from the surface of the pit lake. Both samples were kept under refrigeration and immediately shipped to Global ARD in Burnaby, British Columbia.

## 4.2 Analytical Methods

### 4.2.1 Physical Characterization

Aliquots of fresh sludge were analyzed for total solids analysis at Global ARD by gravimetric analysis. An aliquot of fresh sludge was then submitted to the University of Saskatoon geochemical lab for particle size analysis using a Malvern Mastersizer.

### 4.2.2 Mineralogical Characterization

An aliquot of filtered sludge was submitted to SGS Minerals in Burnaby, BC for mineralogical analysis. At SGS, the sample was air dried then micro-riffled to prepare 2 carbon-coated polished sections using the dry polishing method to retain water-soluble mineral phases.

The sample was then analyzed for automated mineralogical analysis using the TESCAN Integrated Mineral Analyzer (TIMA-X). Energy Dispersive Spectrometry (EDS) analysis was used to quantify the chemistry of mineral phases not already present within the TESCAN mineral library. Further details on the mineralogical methods and quality assurance procedures are provided in Appendix A.

### 4.2.3 Static Characterization

An aliquot of filtered and dried sludge was analyzed at Global ARD for elemental content by ICP-MS analysis following an aqua regia partial digestion, elemental content by ICP-AES analysis following a lithium metaborate near total digestion, total carbon and sulphur by Leco, and sulphate sulphur following a hydrochloric acid leach.

To measure the buffering capacity of the sludge, a 10g aliquot of filtered sludge was titrated with sulphuric acid at Global ARD. The procedure involved continuous addition of 1N sulphuric acid to the sample using a titration dropper while the sample was constantly agitated. The titration was continued until a pH endpoint of 2.

### 4.2.4 Pit Water Sample and Sludge Filtrate Analysis

The Vangorda Pit Lake Sample, the Faro Pit Lake Sample, and the sludge filtrate samples were analyzed at Global ARD for pH, electrical conductivity (EC), oxidation reduction potential (ORP), dissolved oxygen (DO), acidity, alkalinity, dissolved sulphate, chloride, fluoride, nitrate, nitrite, ammonia, orthophosphate, dissolved organic carbon (DOC), total suspended solids (TSS), turbidity, and analysis of dissolved concentrations of thirty-nine elements.

### 4.2.5 Extraction Tests

#### Shake Flask Extractions

Shake-flask extractions (SFEs) were conducted at Global ARD using a modified procedure with a 1:20 ratio of dry sludge to water (27.5 g of dry sludge to 750 mL of water) used in an effort to prevent solubility limits from being reached and limit the ability of the sludge to quickly buffer the test solution to alkaline pH. The SFEs were conducted with gentle agitation rather than shaking to mimic the storage conditions and a 96-hour reaction time was used so that equilibrium could be achieved. The SFE procedure was conducted with the following variations:

1. DI water (and duplicate test)
2. Faro pit water (to assess solubility under neutral conditions)
3. Vangorda pit water (to assess solubility under acidic conditions)

#### Sequential Extraction Tests

A customized sequential extraction test procedure was developed following review of the mineralogy data. The procedure aimed to test the solid phase associations of the major and trace elements within the sludges to determine the total amount of these elements hosted within exchangeable, water soluble, reducible, and acid soluble fractions. The procedure was intended to be performed on 1 g of dry sludge with the reagents and equilibration conditions summarized in Table 4-2. However, during the first iteration of the extraction the sample leachate volumes were insufficient to yield low detection limits and the sample was completely dissolved following the reducible step. The test was therefore repeated using a 10 g sample and proportionally larger volumes of reagents (i.e. 10x volumes). The final reagents, reagent volumes, and equilibration conditions used are summarized in Table 4-2. The 10 g sample was still dissolved by the reducible step and the final two steps could not be completed.

**Table 4-2: Customized Extraction Test Procedure**

| Extraction Step | Target Phases | Target Minerals | Reagent | Equilibration Time | Reference | Note |
|---|---|---|---|---|---|---|
| 1 | Exchangeable | Elements adsorbed to ion exchange sites on Fe3+ and Mn3+ oxide surfaces | 400 ml 1M CaCl2 | 2 hours end over end shaking | Pickering (1986) | |
| 2 | Water-Soluble | Sulphate Minerals | 1000 ml DI water, wait for results and repeat step if SO4 >1500 mg/L | 48 hrs, gentle swirl | variation of MEND (2009) | Step repeated until dissolved sulphate results <1,000 mg/L |
| 3 | Reducible | Fe and Mn oxides and hydroxides | 400 ml 0.04 M hydroxylamine hydrochloride in 25% acetic acid | 2 hours in 90 C water bath with mixing every 30 minutes | Tessier (1979) | Step repeated twice on replicate sample |
| 4 | Moderately acid soluble | Remaining sulphates and hydroxides | 1N HCl added with titration dropper until pH holds steady at 3 | Beaker constantly stirred as HCl is added, HCl addition and pH documented at each step as done for sludge titration | Customized method | Not completed |
| 5 | Residual | QA/QC | 4-acid digestion | | Standard Method | |

Source: Z:\01_SITES\Faro\!101_Investigations\2020_WTP_SludgeCharacterization\1. Proposal and Lab instructions\Selective Extraction\[ExtractionMethodPlan_1CA030.025_JED_Rev01.xlsx]

The reproducibility of the method was tested by performing the entire method in replicate. Additionally, a blank was tested at steps 1, 3, and 4 to evaluate the contribution for each of the reagents.

### 4.2.6 Aging Tests

#### Test Work Program Design

The aging test work program was designed to test the long-term stability of the sludges under range of pH and Eh conditions. Each aging test was setup at Global ARD in Burnaby, BC using a using a low (1:20) ratio of sludge to water (25 g of dry sludge to 475 mL of water) in an effort to prevent solubility limits from being reached and limit the ability of the sludge to quickly buffer the test solution to alkaline pH. The aging tests were conducted under oxic and anoxic conditions, with the addition of 0.575 g/L ethanol (equivalent to 300 mg/L total carbon) in an attempt to force reducing conditions in the anoxic conditions, using the variations shown in Figure 4-1.

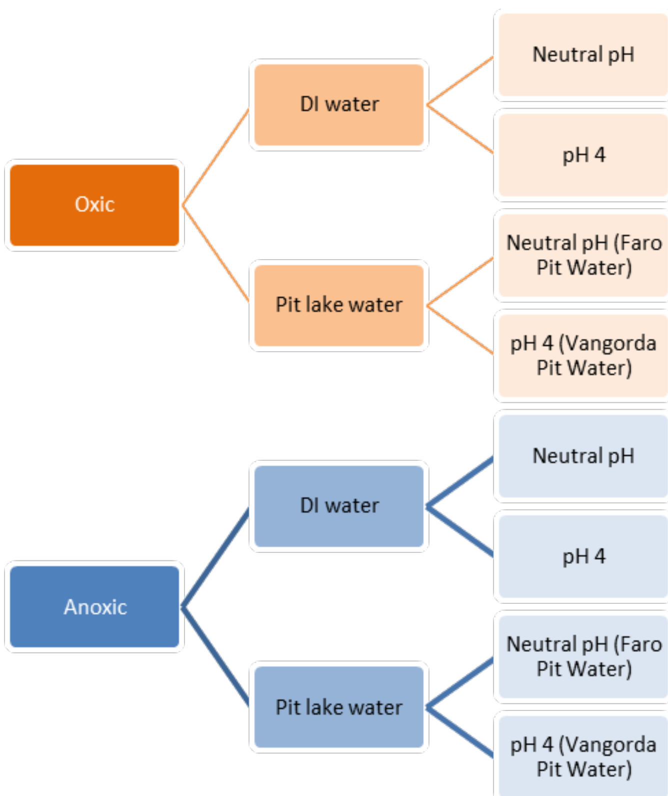


**Figure 4-1: Aging Test Variations**

#### Aging Test Setup

The oxic aging tests are shown in Figure 4-2. Setup of the tests consisted of the following:

- Placement of 25 g of dry sludge into twenty-four open-topped glass bottles (4 aging test variations, 1 bottle per sample interval).
- Preparation of acidic DI water solution by adding $H_2SO_4$ with a titration dropper until a pH of 4 was achieved.
- Addition of 475 mL of solution to each sample bottle using the variations outlined in Figure 4-1 with the bottle gently swirled following addition. Following mixing of the sludge with the solution, the pH and ORP were measured hourly for seven hours.
- The oxic aging tests were then covered with parafilm when not being manipulated.


**Figure 4-2: Oxic Aging Test Setup**

The anoxic aging test are shown in Figure 4-3. Setup of the tests consisted of the following:

- Placement of 25 g of dry sludge into twenty-four screw top glass bottles (4 aging test variations, 1 bottle per sample interval).
- Addition of 475 mL of solution to each sample bottle using the variations outlined in Figure 4-1 with the bottle gently swirled following addition.
- Setup of a blank sample (bottle filled with DI water) for each anoxic test variation which was treated identically to the other bottles throughout the duration of testing.
- Each bottle was then capped with a sealed screw top lid and placed in an anaerobic glove box. Within the glove box, each aging test was flushed for 2 hours with $N_2$ gas.

- Following flushing, the pH, EC, and ORP was measured and each test was dosed with ethanol (final concentration 0.575 g/L) to promote microbial reduction. The stopper for each screw-top bottle lid was then attached to a tedlar bag filled with nitrogen to mitigate any oxygen intrusion into the glove box.
- During the length of the aging tests, the glove box was flushed with $N_2$ weekly to maintain anoxic conditions and an oxygen absorber and indicator were used to facilitate and monitor low oxygen concentrations, respectively.

**Figure 4-3: Anoxic Aging Test Setup**

### Aging Test Sampling

Aging tests were sampled following the frequency outlined in Table 4-3. The sampling procedure for the oxic and anoxic aging test was identical. Anoxic aging tests were sampled outside the glove box as it took less than a minute to process the samples. Prior to sampling, the undisturbed sample solution was measured for pH, EC, and ORP. The sample was then swirled, with pH, EC, and ORP measured once again following swirling. These parameters were measured inside the glove box for the anoxic samples. The solution was then sampled for analysis of pH, ORP, EC, total alkalinity, acidity, sulphate, chloride, fluoride, bromide, nitrate, nitrite, ammonia, and a dissolved element scan by ICP-MS. Total organic carbon (TOC) and dissolved organic carbon (DOC) were also measured on the anoxic test variations for months four and seven.

**Table 4-3: Aging Test Sample Schedule**

| Time Point | Oxic Aging Tests | Anoxic Aging Tests |
|---|---|---|
| T0 | 2 weeks | - |
| T1 | 1 month | 1 month |
| T2 | 2 months | 2 months |
| T3 | 3 months | 3 months |
| T4 | 4 months | 4 months |
| T5 | 7 months | 7 months |

## 4.3 Data Quality Assurance (QA) and Quality Control (QC)

In addition to laboratory quality assurance and quality control (QA/QC) programs, SRK follows internal QA/QC procedures as outlined in the SRK Expectations for Laboratory Geochemical Data Quality (2019b). The sludge characterization program included the following QA/QC components in addition to the lab QA/QC procedures:

- Static characterization:
  - A duplicate sample (split following sludge homogenization) underwent static testing.
  - SRK monitors static results from duplicates, in addition to checking lab-initiated QC samples (duplicates, blanks and certified reference materials) against expected values.
- Pit water and sludge filtrate analysis:
  - A duplicate sludge filtrate sample was analyzed.
  - Data were evaluated for ion balance, for reproducibility, and deviations from previously observed trends.
- Shake-flask extraction tests:
  - A duplicate and blank extraction test were conducted.
  - Data were evaluated for ion balance, for contamination, and for reproducibility.
- Sequential extraction tests:
  - The entire extraction procedure was conducted in duplicate and blanks were tested at each step where reagents were added to evaluate contribution from reagents.
  - Data were evaluated for ion balance and for reproducibility.
- Aging tests:
  - A blank test was operated for each anoxic test variation to assess potential contamination from the test setup.
  - Data were evaluated for ion balance, for contamination, and deviations from previously observed trends.

Results that were outside SRKs criteria were subject to further evaluation or re-checks. QA/QC results of the sequential extraction tests are provided in Section 5.6.2 with results of SRK's QA/QC assessment for the remaining tests are provided in Appendix B. In summary, the data passed the QA/QC checks and were considered acceptable and no re-checks were outstanding.

# 5 Results

## 5.1 Sludge Filtrate and Pit Water Chemistry

A summary of the sludge filtrate pit water chemistry results for selected parameters is provided in Table 5-1 with the full set of analytical data provided in Appendix C.

The sludge filtrate had a slightly alkaline pH of 8.4 with low alkalinity (9.5 mg/L) and an electrical conductivity of 3000 µS/cm. Cations within the sludge filtrate were dominated by calcium (480 mg/L) and magnesium (170 mg/L) with anions dominated by sulphate (2200 mg/L). Ammonia was the main nitrogen form within the filtrate at 1.1 mg/L, followed by nitrite (0.49 mg/L) and nitrate (0.18 mg/L) while total organic carbon was present in an abundance of 4.4 mg/L. Concentrations of all parameters in the sludge filtrate were less than concentrations in the Faro pit water. Zinc had a notably low concentration of 0.028 mg/L.

The Faro pit water had a neutral pH of 6.9 with measurable levels of acidity (66 mg/L as $CaCO_3$) and alkalinity (48 mg/L as $CaCO_3$) and an electrical conductivity of 1900 µS/cm. Cations within the Faro pit water were dominated by calcium (210 mg/L), magnesium (110 mg/L) and acidity (66 mg/L) with anions dominated by sulphate (1200 mg/L). Ammonia was the main nitrogen form at 1.5 mg/L followed by nitrate at 0.15 mg/L while total organic carbon was present in an abundance of 1.1 mg/L. Compared to the sludge filtrate, the Faro pit water had slightly higher concentrations of most metals and trace elements (i.e. cadmium cobalt, copper, iron, nickel, and selenium) and significantly higher concentrations of manganese (12 mg/L) and zinc (33 mg/L).

The Vangorda pit water had an acidic pH of 3.6 with 560 mg/L acidity, no measurable alkalinity and an electrical conductivity of 2700 mg/L. Cations in the Vangorda pit water were dominated by calcium (230 mg/L), magnesium (150 mg/L) and iron (110 mg/L) with anions dominated by sulphate (1900 mg/L). Compared to the Faro pit water, the Vangorda pit water showed slightly higher concentrations of most trace elements (i.e. As, Cd, Co, Cu, Pb, Ni, Se) and significantly higher concentrations of zinc (160 mg/L), iron (110 mg/L) and manganese (49 mg/L). The Vangorda pit water showed concentrations in the range of those predicted in the Faro pit lake following acidification (Section 2.1.2) indicating that the Vangorda pit water is an appropriate analog to measure the interaction between the sludge and the Faro pit lake water following acidification.

**Table 5-1: Summary of Pit Water and Filtrate Chemistry**

| Parameter | Unit | Sludge Filtrate | Vangorda Pit | Faro Pit |
|---|---|---|---|---|
| pH | pH units | 8.4 | 3.6 | 6.9 |
| EC | µS/cm | 3000 | 2700 | 1900 |
| Acidity | mg $CaCO_3$/L | <0.5 | 560 | 66 |
| Alkalinity | mg $CaCO_3$/L | 9.5 | <0.5 | 48 |
| Dissolved Sulphate | mg/L | 2200 | 1900 | 1200 |
| Nitrate (as N) | mg/L | 0.18 | 0.1 | 0.19 |
| Nitrite (as N) | mg/L | 0.49 | 0.028 | <0.005 |
| Ammonia (as N) | mg/L | 1.1 | 0.39 | 1.5 |
| Dissolved Organic Carbon | mg/L | 4.4 | 1.1 | 1.5 |
| Total Organic Carbon | mg/L | 4.4 | 0.8 | 1.1 |
| Total Suspended Solids | mg/L | 4.0 | 18 | 6.0 |
| Sb | mg/L | <0.0001 | <0.0001 | <0.0001 |
| As | mg/L | 0.0007 | 0.0014 | 0.0003 |
| Cd | mg/L | 0.00009 | 0.079 | 0.011 |
| Ca | mg/L | 480 | 230 | 210 |
| Co | mg/L | 0.0007 | 0.6 | 0.11 |
| Cu | mg/L | 0.0007 | 0.3 | 0.0013 |
| Fe | mg/L | <0.02 | 110 | 0.27 |
| Pb | mg/L | <0.0005 | 0.072 | <0.0005 |
| Mg | mg/L | 170 | 150 | 110 |
| Mn | mg/L | 0.0013 | 49 | 12 |
| Ni | mg/L | 0.0026 | 0.46 | 0.19 |
| K | mg/L | 12 | 3 | 9.7 |
| Se | mg/L | 0.0009 | 0.0043 | 0.0021 |
| Na | mg/L | 31 | 7.6 | 24 |
| Zn | mg/L | 0.028 | 160 | 33 |

Source: Z:\01_SITES\Faro\!101_Investigations\2020_WTP_SludgeCharacterization\3. Working Files\[Faro Sludge_WorkingFiguresandTables_1CA030.025_Rev00.xlsx]

Notes:
Elements represent dissolved concentrations

## 5.2 Sludge Physical Characteristics

### 5.2.1 Moisture and Solids Content

Results from total solids analysis are presented in Table 5-2. The laboratory values for the sludge slurry compared well with estimates of solids content and specific gravity performed on sludge following the pilot plant testing by AWT (2018). Full results are presented in Appendix C.

**Table 5-2: Sludge Solids Content**

| Sample ID | Sample Volume | Slurry Weight | Slurry Specific Gravity | Wet Cake Weight | Dry Cake Weight | % Moisture Filtered Sludge | Slurry % Solids |
|---|---|---|---|---|---|---|---|
| | mL | g | g/ml | g | g | % | % |
| Homogenized Sludge | 1000 | 1100 | 1.1 | 790 | 230 | 71% | 20% |
| Homogenized Sludge Duplicate | 1000 | 1100 | 1.1 | 800 | 230 | 71% | 20% |

Source: Z:\01_SITES\Faro\!101_Investigations\2020_WTP_SludgeCharacterization\3. Working Files\[Faro Sludge_WorkingFiguresandTables_1CA030.025_Rev00.xlsx]

### 5.2.2 Particle Size Distribution

The particle size distribution of the sludge is shown in Figure 5-1, with full results provided in Appendix D. The sludge particle size showed a relatively normal distribution with a median particle size of 20 microns (minimum and maximum= 0.7 um and 540 um or 0.54 mm respectively).

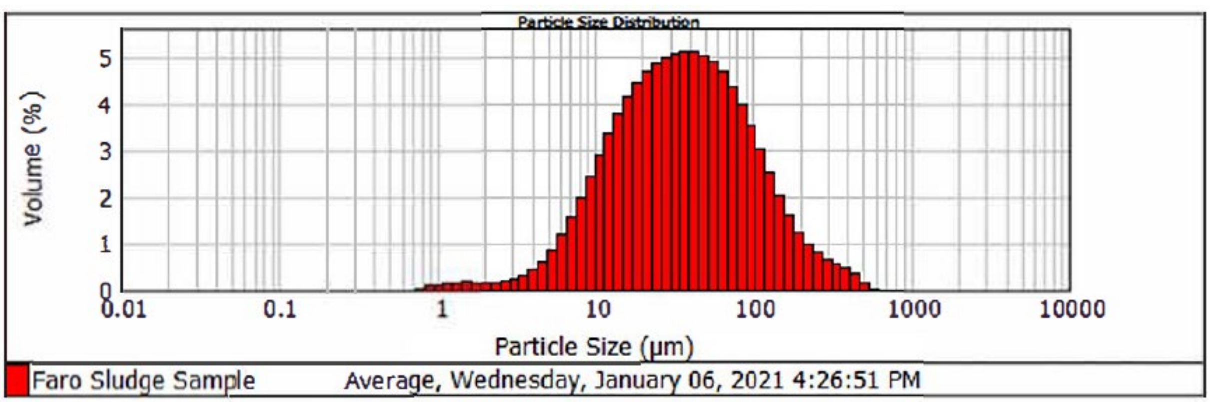


**Figure 5-1: Sludge Particle Size Distribution**

## 5.3 Mineralogy

### 5.3.1 Interpretation of SEM-EDS Data

Results of scanning electron microscope (SEM) electron dispersive spectrometry (EDS) spot analysis were used to interpret the spectra of an array of abundant oxygen rich phases containing various combinations of magnesium, iron, calcium, manganese, zinc, and sulphur which were not in the TIMA-X mineral library. As EDS cannot determine the abundances of light elements such as carbon and hydrogen, the chemical formula of each mineral must be determined based on the relative proportions of each element by mass. Based on review of the mineralogical composition of sludges produced through treatment of waste waters at similar mines (MEND 2013), it was determined that these phases likely represented hydroxy-sulphate, hydroxide, or oxy-hydroxide precipitates from the lime treatment process. Comparison of the relative abundances of oxygen and sulphur present within each phase to abundances of cations measured by SEM-EDS determined that the unknown mineral phases likely represent either non-hydrated or hydrated oxy-hydroxides as hydroxide phases would contain less oxygen mass and hydroxy-sulphate phases would contain a greater mass of sulphur than was measured by SEM-EDS. However, the precipitates could also represent a more complex phase such as the layered double hydroxides described by Gammons and Icopini (2019) of the type $M(II)OH_{2-x}M(III)(OH)_3(SO_4)_{x/2}$ where M(II) is $Fe^{2+}$, $Mg^{2+}$, $Mn^{2+}$, or $Zn^{2+}$ and M(III) is $Al^{3+}$ or $Fe^{3+}$. Double layered hydroxides with this composition would have similar levels of oxygen and sulphur as the range measured by SEM-EDS. As the mineralogy of these phases cannot conclusively be determined, they are henceforth referred to as “O-phases” within this report.

### 5.3.2 Bulk Mineralogy Data

The mineralogical results from TIMA-X bulk mineralogical analysis are provided in Table 5-3, with the full mineralogy laboratory report provided in Appendix A. Key points for the data are summarized as follows:

- The sample was dominated by O-phases which comprised 62 weight percent (wt %) of the sample. The Ox-phases had chemical variations which were organized within the TIMA-X software into five groupings:
  - Zn, Fe, Mg, Mn, S, (Ca, Si) - O phase which contained 14% Zn, 9.9% Fe, 9.1% Mg, 6.7% Mn, 5.9% S, 4.5% Ca, 1.48% Si, and 48% O.
  - Ca, S, (Mn) - O phase which contained 28% Ca, 21%S, 2% Mn, 0.4% Zn, 0.28% Mg, and 47% O.
  - Mg, Al, S, (Zn, Si) - O phase which contained 20% Mg, 7.5% Al, 5.2% S, 3.8% Zn, 2.2% Si, 0.45% Ca, 0.018% Fe, and 61% O.
  - Fe, Zn, Mg, (S, Si) – O phase which contained 16% Fe, 13% Zn, 13% Mg, 4.7% S, 1.5% Si, and 52% O.
  - Mg, Fe, Ca, Zn, (S) - O Phase for which the mineral chemistry could not be quantified due to a lack of beam counts.

- Gypsum was the second most abundant phase and occurred in an abundance of 18 wt %, while the sulphates barite and jarosite were detected in trace quantities. SEM-EDS analysis of gypsum grains determined that gypsum contained 2% Mn, 0.4% Zn, and 0.28% Mg.
- The carbonate minerals calcite and dolomite/ankerite were detected in significant quantities (9.6 wt % and 3.6 wt % respectively).
- Oxide phases were detected in a total abundance of 6.0%, with 5.5% of the oxides made up of Zn-oxide (1.9%) and Mn, Zn-oxide (3.6%) and the remainder classified as undifferentiated oxide which could not be further segregated. SEM-EDS of the Mn-Zn oxide grains determined that this phase contained sub-equal proportions of Mn and Zn with trace iron (2.2%).
- The remainder of the sample was made up of traces of the sulphate minerals jarosite and barite, undifferentiated silicates, elemental sulphur, and undifferentiated sulphides which were described as containing traces of pyrite.

Overall, mineralogy of the Faro WTP sludge is similar to ARD neutralization sludges from several other mines in western Canada which also contained significant amounts of gypsum and traces of carbonates, barite, pyrite, and oxides (MEND 2013).

**Table 5-3: Summary of TIMA-X Bulk Mineralogy Results**

| Mineral Group | Mineral | Formula | Modal Abundance (%) |
|---|---|---|---|
| O phases | Zn, Fe, Mg, Mn, S (Ca, Si) - O phase | - | 28 |
| O phases | Ca, S (Mn) - O phase | - | 18 |
| O phases | Fe, Zn, Mg (S, Si)- O Phase | - | 13 |
| O phases | Mg, Fe, Ca, Zn (S) - O phase | - | 1.2 |
| O phases | Mg, Al, S (Zn, Si) - O phase | - | 1.1 |
| Sulphates | Gypsum | $CaSO_4$ | 18 |
| | Jarosite | $KFe^{3+}_3(OH)_6(SO_4)_2$ | trace |
| | Barite | $BaSO_4$ | trace |
| Carbonates | Calcite | $CaCO_3$ | 9.6 |
| | Carbonates | $(Ca, Mg, Fe)(CO_3)_2$ | 3.6 |
| Oxides | Mn, Zn (Fe) -Oxide | $(Mn, Zn, Fe)O_2$ | 3.6 |
| | Zn-Oxide | ZnO | 1.9 |
| | Oxides | | 0.46 |
| Silicates | Silicates | | 1.3 |
| Sulphur Forms | Complex Sulfur | | 0.14 |
| | Sulphides | | 0.04 |

Source: Z:\01_SITES\Faro\!101_Investigations\2020_WTP_SludgeCharacterization\3. Working Files\[Mineralogy_Interp_1CA030.025_Rev00.xlsx]

Notes:

Pyrite identified within sulphide grouping

Carbonate grouping includes dolomite and ankerite

### 5.3.3 Zinc Deportment

The deportment of zinc as calculated using the SEM-EDS concentration of zinc within each identified mineral phase and whole-rock zinc abundances is shown in Table 5-4 which shows that 77% of zinc is present within the array of O-phases with 22% hosted within Zn and Mn oxides. Trace amounts of zinc are also present with gypsum and calcite.

**Table 5-4: Zinc Deportment**

| Mineral | Mass % of Zn |
|---|---|
| Zn, Fe, Mg, Mn, S, (Ca, Si) - O Phase | 35 |
| Ca, S, (Mn) - O Phase | 23 |
| Fe, Zn, Mg, (S, Si) - O Phase | 16 |
| Mg, Fe, Ca, Zn, (S) - O Phase | 1.9 |
| Mg, Al, S, (Zn, Si) - O Phase | 0.69 |
| Mn, Zn (Fe)-Oxide | 11 |
| Zn-Oxide | 11 |
| Gypsum | 1.0 |
| Calcite | 0.31 |
| Other | 0.08 |

Source: Z:\01_SITES\Faro\!101_Investigations\2020_WTP_SludgeCharacterization\3. Working Files\[Mineralogy_Interp_1CA030.025_Rev00.xlsx]

## 5.4 Solid Phase Chemistry

Table 5-5 presents the treatment sludge composition results for a selected set of parameters on a dry mass basis with the full dataset of results provided in Appendix C.

Only 49% of the sludge's dry weight could be quantified and the sample had a loss on ignition of 28%, indicative of the presence of abundant volatiles such as OH and $H_2O$. Based on the mineralogical composition of the sample (Section 5.3), the loss on ignition likely reflects de-volatization of water and hydroxide from hydroxide and hydrated mineral phases.

Calcium (9.0%), magnesium (7.7%), iron (6.4%), sulphur (5.4%), manganese (2.2%), and carbon (1.5%) were the dominant major elements present within the sludge, reflecting the presence of these elements within the O-phases and within gypsum (calcium and sulphur) and carbonate (carbon). Potassium and sodium were not detected, while traces of silica (0.73%), aluminum (0.045%), and phosphorus (0.0044%) comprised the remainder of the sludge's major element composition.

HCl extractable sulphur (3.9%) comprised the majority of the sulphur within the sample, indicating that the majority of the sulphur was hosted in acid soluble phases such as gypsum or O-phases.

Zinc was the dominant trace element within the sludge with an abundance of 15%. Cobalt and nickel were also detected in appreciable amounts (280 and 310 ppm respectively), while other trace elements had near detection or relatively low concentrations.

**Table 5-5: Treatment Sludge Composition on a Dry Mass Basis**

| Method | Parameter | Unit | Homogenized Sludge |
|---|---|---|---|
| Leco | Total C | % | 1.9 |
| | Total S | % | 5.4 |
| | HCl Extractable Sulphur | % | 3.9 |
| Whole Rock Digestion | Al | % | 0.048 |
| | Ca | % | 9.9 |
| | Fe | % | 6.4 |
| | K | % | <0.007 |
| | Mg | % | 7.7 |
| | Mn | % | 2.2 |
| | Na | % | <0.006 |
| | P | % | 0.0044 |
| | Si | % | 0.73 |
| Aqua Regia Digestion | As | ppm | 2.2 |
| | Cd | ppm | 29 |
| | Co | ppm | 280 |
| | Cr | ppm | 3.0 |
| | Cu | ppm | 6.6 |
| | Mo | ppm | 0.10 |
| | Ni | ppm | 310 |
| | Pb | ppm | 4.2 |
| | Sb | ppm | 0.60 |
| | Se | ppm | <1 |
| | U | ppm | 2.7 |
| | V | ppm | 31 |
| | Zn | % | 15 |

Source: Z:\01_SITES\Faro\!101_Investigations\2020_WTP_SludgeCharacterization\3. Working Files\[Faro Sludge_WorkingFiguresandTables_1CA030.025_Rev00.xlsx]

## 5.5 Buffering Capacity

At the pH endpoint of the treatment sludges following storage (pH 8 to 9), the total alkalinity remaining in solution is low (9 mg $CaCO_3$/L). Most of the alkalinity is stored in the form of hydroxide in the precipitated O-phases and as calcite, dolomite and ankerite. Results of the laboratory titration (Figure 5-2) indicated the sludge had the ability to buffer 0.0087 mols $H^+$/g on a dry basis at a pH above 5. Incorporating the alkalinity of the sludge filtrate and the solids content of the homogenized sludge (Section 5.2.1), the sludge had the ability to buffer 2.0 mols $H^+$/L at a pH range above 5. Using the expected solids content of the sludge during full scale operation (~25%), the sludge would have the ability to buffer 2.5 mols $H^+$/L at a pH above 5.

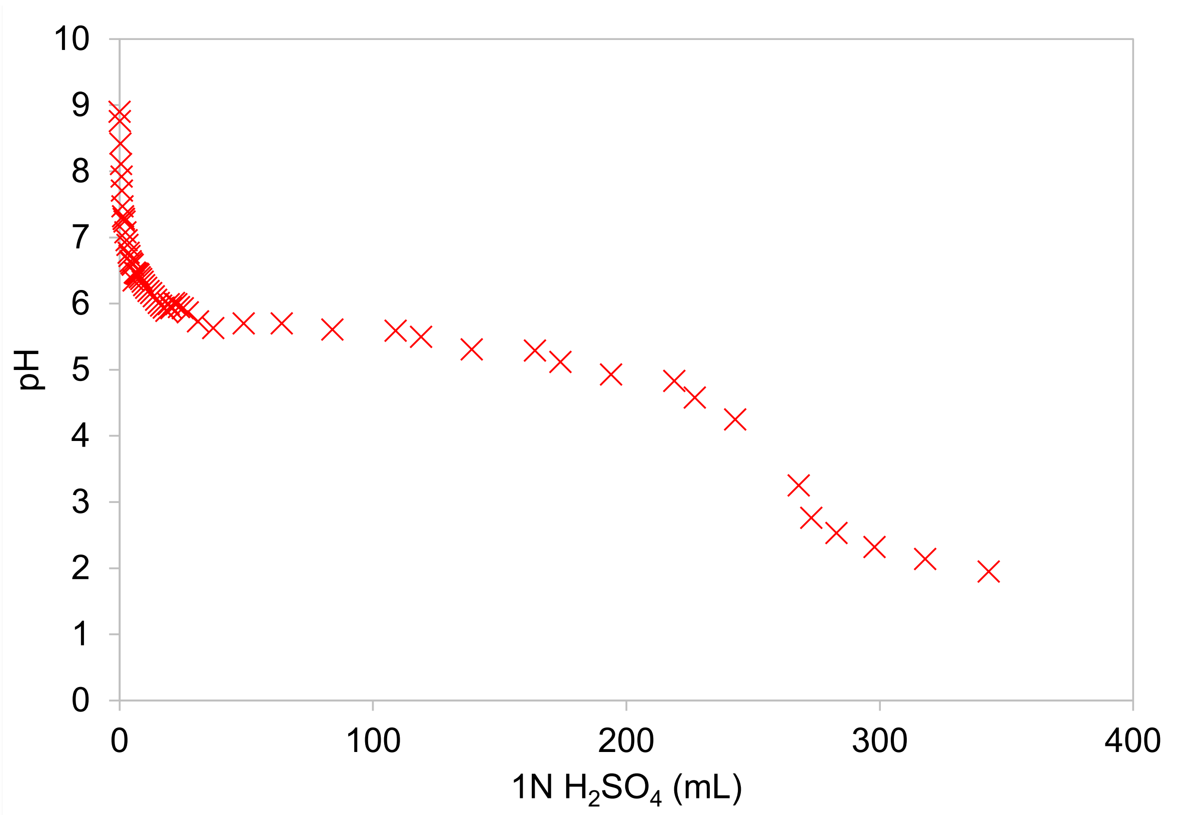


**Figure 5-2: Results of Sludge Titration**

## 5.6 Leach Tests

### 5.6.1 Shake Flask Extractions

Results of the shake-flask extraction tests are expressed as loadings (i.e. as mg constituent/kg sludge). A summary of the SFE leachate concentrations and loadings for selected parameters is presented in Table 5-6, with the full analytical dataset provided in Appendix C. For the SFE variations conducted with Faro and Vangorda pit water as the lixiviant, the loadings calculations incorporated the initial load within the solution so that loadings only reflected the net release of chemical load from the sludge. For parameters which decrease upon reaction with the sludge, this results in negative loadings. This equation for each parameter is of the form:

$$Loading\left(\frac{mg}{kg}\right) = \frac{(Leachate\ conc.\left(\frac{mg}{L}\right) x\ Leachate\ Volume\ (L) - Lixiviant\ conc.\left(\frac{mg}{L}\right) x\ Lixiviant\ Volume\ (L))}{mass\ of\ sludge\ (kg)}$$

The results are discussed as follows:

- The sludge effectively buffered each of the three SFE variations to neutral pHs ranging from 8.3 to 8.7. In each SFE variation, acidity was below detection. Alkalinity showed net loadings of 310 and 500 mg/kg as $CaCO_3$ in the DI water and Vangorda pit water variations respectively but showed a reduction in alkalinity loadings within the Faro pit water variation.
- The sludge contributed significant loadings of sulphate (21,000 to 41,000 mg/kg), calcium (4300 to 9600 mg/kg) and magnesium (3900 to 5800 mg/kg) reflecting dissolution of water-soluble minerals including gypsum. The concentration of sulphate within the leachate of all three variations ranged from 2040 to 2940 mg/L which is the typical range at which gypsum precipitation occurs in the presence of elevated magnesium concentrations. This indicates release of sulphate and calcium was likely limited by equilibrium with gypsum and that loadings would be greater at higher water to solid ratios. Magnesium showed greater concentrations and loadings within the Faro pit water and Vangorda pit water variations (4200 and 5800 mg/kg respectively) suggesting leaching was likely controlled by pH.
- Loadings of zinc and manganese were slightly positive in the DI water variation (0.98 and 0.98 mg/kg respectively), while both parameters showed a negative loading for both pit water variations reflecting the limited solubility within the SFE leachates under buffered conditions.
- Several other parameters including Cl, NO3, NO2, K, and Na showed lower but consistently positive loadings in all three SFE variations indicating the presence of these constituents within water soluble phases within the sludge.
- F, As, Cd, Co, and Mn showed slight positive loadings within the DI water SFE variation reflecting leaching under dilute conditions but negative loadings for both pit water variations likely reflecting the presence of solubility limits for these parameters or iron hydroxide minerals within the SFE tests under neutral pH conditions.
- Pb, Mo, Hg, Se, U, and V were detected near or below detection limits within both the pit water and the SFE leachates indicating the lack of these constituents within water-soluble phases within the sludge.

**Table 5-6: Summary of SFE Results and Loadings**

| | | Pit Water Concentrations | | SFE Results | | | SFE Loadings | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Unit** | **Faro Pit** | **Vangorda Pit** | **DI Water** | **Faro Pit Water** | **Vangorda Pit Water** | **Unit** | **DI Water** | **Faro Pit Water** | **Vangorda Pit Water** |
| Weight of dry sample | g | | | 38 | 38 | 38 | g | 38 | 38 | 38 |
| Volume of water | mL | | | 750 | 750 | 750 | mL | 750 | 750 | 750 |
| pH | pH units | 6.9 | 3.6 | 8.7 | 8.8 | 8.3 | pH units | 8.7 | 8.8 | 8.3 |
| EC | µS/cm | 1900 | 2700 | 3100 | 3700 | 4100 | µS/cm | 3100 | 3700 | 4100 |
| ORP | mV | 120 | 280 | 120 | 50 | 130 | mV | 120 | 50 | 130 |
| Acidity | mg $CaCO_3$/L | 66 | 560 | 0.5 | 0.5 | 0.5 | mg CaCO3/kg | <10 | <10 | <10 |
| Alkalinity | mg $CaCO_3$/L | 48 | 0.5 | 16 | 18 | 26 | mg CaCO3/kg | 310 | -600 | 500 |
| SO4 | mg/L | 1200 | 1900 | 2000 | 2500 | 2900 | mg/kg | 41000 | 26000 | 21000 |
| Cl | mg/L | 1.3 | 0.58 | 0.49 | 1.6 | 0.73 | mg/kg | 9.8 | 5.4 | 3 |
| F | mg/L | 0.48 | 0.48 | 0.34 | 0.41 | 0.46 | mg/kg | 6.8 | -1 | -0.4 |
| Nitrate (as N) | mg/L | 0.19 | 0.1 | 0.019 | 0.19 | 0.17 | mg/kg | 0.38 | 0.08 | 1.3 |
| Nitrite (as N) | mg/L | 0.005 | 0.028 | 0.11 | 0.099 | 0.12 | mg/kg | 2.2 | 2.1 | 1.9 |
| Sb | mg/L | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | mg/kg | <0.002 | <0.002 | <0.002 |
| As | mg/L | 0.0003 | 0.0014 | 0.0003 | 0.0003 | 0.0003 | mg/kg | 0.006 | 0 | -0.02 |
| Cd | mg/L | 0.011 | 0.079 | 0.00008 | 0.00013 | 0.0014 | mg/kg | 0.0016 | -0.2 | -2 |
| Ca | mg/L | 210 | 230 | 480 | 450 | 450 | mg/kg | 9600 | 4800 | 4300 |
| Cr | mg/L | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | mg/kg | <0.01 | <0.01 | <0.01 |
| Co | mg/L | 0.11 | 0.6 | 0.0006 | 0.001 | 0.015 | mg/kg | 0.012 | -2 | -10 |
| Cu | mg/L | 0.0013 | 0.3 | <0.0005 | <0.0005 | <0.0005 | mg/kg | <0.01 | -0.04 | -6 |
| Fe | mg/L | 0.27 | 110 | <0.02 | <0.02 | <0.02 | mg/kg | <0.4 | -6 | -2000 |
| Pb | mg/L | 0.0005 | 0.072 | <0.0005 | <0.0005 | <0.0005 | mg/kg | <0.01 | <0.01 | -1 |
| Mg | mg/L | 110 | 150 | 200 | 320 | 440 | mg/kg | 3900 | 4200 | 5800 |
| Mn | mg/L | 12 | 49 | 0.0007 | 0.015 | 5.7 | mg/kg | 0.014 | -200 | -900 |
| Hg | mg/L | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | mg/kg | <0.01 | <0.01 | <0.01 |
| Mo | mg/L | 0.0001 | 0.0005 | 0.0002 | 0.0002 | 0.0001 | mg/kg | 0.004 | 0.006 | -0.008 |
| Ni | mg/L | 0.19 | 0.46 | <0.0005 | 0.0008 | 0.01 | mg/kg | <0.01 | -4 | -9 |
| K | mg/L | 9.7 | 3 | 1.3 | 11 | 4.3 | mg/kg | 26 | 29 | 25 |
| Se | mg/L | 0.0021 | 0.0043 | <0.0005 | <0.0005 | <0.0005 | mg/kg | <0.01 | -0.05 | -0.1 |
| Ag | mg/L | <0.00008 | <0.00008 | <0.00008 | <0.00008 | <0.00008 | mg/kg | <0.002 | <0.002 | <0.002 |
| Na | mg/L | 24 | 7.6 | 3.5 | 27 | 11 | mg/kg | 70 | 76 | 57 |
| U | mg/L | 0.00027 | 0.0062 | <0.00005 | <0.00005 | <0.00005 | mg/kg | <0.001 | -0.006 | -0.1 |
| V | mg/L | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | mg/kg | <0.02 | <0.02 | <0.02 |
| Zn | mg/L | 33 | 160 | 0.049 | 0.059 | 0.13 | mg/kg | 0.98 | -700 | -3000 |

Source: Z:\01_SITES\Faro\!101_Investigations\2020_WTP_SludgeCharacterization\3. Working Files\[Faro Sludge_WorkingFiguresandTables_1CA030.025_Rev00.xlsx]

Notes:

Results expressed in two significant figures

### 5.6.2 Sequential Extraction Tests

Results of the sequential extraction tests are summarized in Table 5-7 and Table 5-8 with the full lab report provided in Appendix C.

The interpretation of these results needs to consider QA/QC issues such as trace element concentrations within the leach solutions and other experimental limitations, described as follows:

- In addition to calcium and chloride, the calcium chloride solution contained levels of arsenic, barium, cadmium, copper, potassium, selenium, sodium, and strontium greater than ten times the detection limit.
- The hydroxylamine hydrochloride and acetic acid solution contained levels of chromium, iron, lithium, manganese, silicon, sodium, titanium, and zinc greater than ten times the detection limit.
- The ion balance of the extract solutions from steps 1 and 2 was <10%. For step 3, fluoride could not be analyzed due to interference and the ion balance therefore exceeded 10%. An analytical recheck confirmed the anion results and the results were accepted as is.
- The relative percent difference (RPD) between the replicates of steps 1, 2 and 3 was <30% for all parameters measured at concentrations greater than ten times the analytical detection limit except for barium which showed poor reproducibility for the water-soluble extraction step (step 2).
- Total element recovery could not be evaluated since the remaining sludge following step 3 (<0.3 g) had insufficient volume for analysis. However, total recovery for steps 1, 2, and 3 (Figure 5-3) showed good reproducibility between both extractions (step 3 performed twice on duplicate step) for parameters detected greater than ten times the analytical detection limit. No parameters showed total element recovery exceeding 100%.

Although the extractions could not be completed due to the near complete dissolution of the sludge during the reducible step (step 3), the results were considered acceptable for determining the exchangeable, water-soluble, and reducible fractions within the sludge. The near complete dissolution of sludge during the reducible step indicates that the moderately acid soluble and residual fractions were an insignificant component of the sludges.

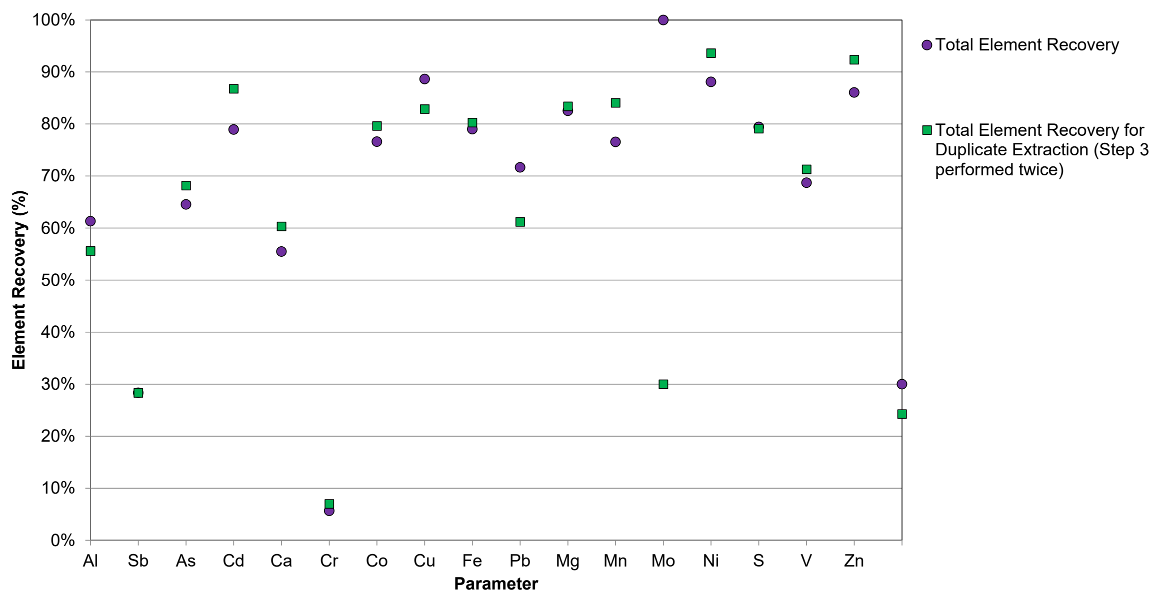


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**Figure 5-3: Element Recovery for Both Replicate Sequential Extractions in Relation to Initial Solid Phase Concentrations. For Steps 1 and 3, the concentration within the reagents was subtracted from the final concentration to account for the composition of the reagent.**

Step 1 of the sequential extraction test was intended to target elements adsorbed to ion exchange sites on $Fe^{3+}$ and $Mn^{3+}$ oxide surfaces using a leachate with a high ionic strength calcium chloride solution. This resulted in mobilization of sulphate (2000 mg/L), magnesium (310 to 330 mg/L), cadmium (0.0053 to 0.0066 mg/L), and zinc (0.45 to 0.46 mg/L) at levels more than one magnitude greater than concentrations in the leach solution. Mobilization of sulphate and magnesium likely reflects dissolution of water-soluble gypsum and magnesium bearing carbonates rather than cation exchange processes. Zinc was also identified as a trace constituent in gypsum (Section 5.3.2) and low levels of zinc and cadmium also likely reflect dissolution of gypsum rather than cation exchange processes. Overall, step 1 of the extraction indicated that the sludge did not contain significant trace metals present within the exchangeable phase.

Step 2 of the sequential extraction test was intended to target elements associated with sulphate minerals using a de-ionized water leachate. This yielded similar results as the SFE's, with the results indicating the sludge contained water-soluble sulphate, calcium, and magnesium content with relatively low levels of most trace elements. In contrast to the SFE results, most trace elements were detected at lower levels reflecting slight dissolution of water-soluble phases by step 1 and the lower solid to liquid ratio of the test (1:200 solid to liquid ratio vs 1:20 ratio).

Step 3 of the sequential extraction test was intended to target elements associated with Fe and Mn oxides and hydroxides using a hydroxylamine hydrochloride and acetic acid solution. This step of the test resulted in near complete dissolution of the sludge. This was likely achieved by total reduction of the hydroxide (O-phases) and oxide phases within the sludge by the reductant hydroxylamine hydrochloride and dissolution of the carbonates within the sludge due to interaction with the acetic acid. The final pH of the extract leachate (pH 3.4) following one cycle suggested near-total dissolution of carbonates. Dissolution of these phases resulted in release of the majority of the elemental content of the sludge with the extraction leachate showing highest concentrations of aluminum, calcium, cadmium, cobalt, iron, magnesium, manganese, silica, and zinc. Overall, step 3 of the sequential extraction indicated the majority of the major and trace elements within the sludge were hosted within reducible phases.

As stated previously, the near complete dissolution of sludge during the reducible step indicates that the moderately acid soluble and residual fractions were an insignificant component of the sludges. However, it should be noted that some of the phases that dissolved in the reducible step could also be susceptible to mobilization under acidic conditions if reducing conditions were not present. In other words, it is likely that the phases that were mobilized in step 3 would have been mobilized in step 4 if step 3 had been skipped.

### Table 5-7: Sequential Extraction Results

| | | | Step-1: Exchangeable | | | Step-2: Water Soluble | | | Step-3: Reducible | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Unit** | **Detection Limit** | **Extraction 1** | **Duplicate Extraction** | **CaCl2 Stock Solution** | **Extraction 1** | **Duplicate Extraction** | **DI Water Solution** | **Extraction 1** | **Duplicate Extraction Cycle 1** | **Duplicate Extraction Cycle 2** | **Stock Solution** |
| pH | pH units | 0.01 | 7.3 | 7.4 | | 8.3 | 8.4 | | 3.4 | 3.4 | 2.4 | |
| EC | µS/cm | 1 | 130000 | 140000 | | 3100 | 3400 | | 12000 | 12000 | 4500 | |
| Acidity | mg $CaCO_3$/L | 0.5 | 64 | 45 | | <0.5 | <0.5 | | 190000 | 190000 | 220000 | |
| Alkalinity | mg $CaCO_3$/L | 0.5 | 13 | 14 | | 13 | 14 | | <0.5 | <0.5 | <0.5 | |
| SO4 | mg/L | 50 | 2000 | 2000 | <50 | 580 | 660 | | 1300 | 1200 | 170 | <50 |
| Cl | mg/L | 5 | 57000 | 59000 | 59000 | 15 | 9.3 | | 1300 | 1300 | 1500 | 1500 |
| F | mg/L | 0.2 | 0.37 | 0.31 | <0.2 | 0.3 | 0.33 | | | | | 18000 |
| Nitrate (as N) | mg/L | 0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | | 53 | 46 | 280 | 280 |
| Nitrite (as N) | mg/L | 0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | | 48 | 53 | 200 | 220 |
| Al | mg/L | 0.02/0.001 | <0.02 | 0.03 | 0.07 | <0.001 | <0.001 | <0.001 | 7.4 | 6.7 | 0.32 | <0.01 |
| Sb | mg/L | 0.002/0.0001 | <0.002 | <0.002 | 0.003 | <0.0001 | <0.0001 | <0.0001 | 0.006 | 0.006 | <0.001 | <0.001 |
| As | mg/L | 0.0002 | 0.012 | 0.012 | 0.014 | <0.0002 | <0.0002 | <0.0002 | 0.041 | 0.043 | 0.02 | 0.004 |
| Cd | mg/L | 0.00001 | 0.0053 | 0.0066 | 0.0003 | 0.00003 | 0.00002 | <0.00001 | 0.57 | 0.63 | 0.0036 | <0.0001 |
| Ca | mg/L | 0.05 | 36000 | 36000 | 37000 | 210 | 230 | <0.05 | 1500 | 1400 | 17 | <0.5 |
| Cr | mg/L | 0.01/0.0005 | <0.010 | <0.010 | <0.010 | <0.0005 | <0.0005 | <0.0005 | 0.012 | 0.013 | 0.008 | 0.009 |
| Co | mg/L | 0.0001 | 0.003 | <0.002 | <0.002 | <0.0001 | <0.0001 | <0.0001 | 5.3 | 5.5 | 0.033 | <0.001 |
| Cu | mg/L | 0.01/0.0005 | <0.010 | 0.01 | 0.018 | 0.0005 | 0.0007 | <0.0005 | 0.16 | 0.15 | 0.006 | <0.005 |
| Fe | mg/L | 1.0/0.02 | <1 | <1 | <1 | 0.01 | 0.01 | <0.02 | 1300 | 1300 | 15 | 0.2 |
| Pb | mg/L | 0.01/0.0005 | <0.010 | <0.010 | 0.021 | <0.0005 | <0.0005 | <0.0005 | 0.09 | 0.079 | 0.008 | <0.005 |
| Mg | mg/L | 0.05 | 310 | 330 | 5.8 | 13 | 13 | <0.005 | 1200 | 1200 | 7.6 | <0.05 |
| Mn | mg/L | 0.0002 | 0.005 | 0.005 | 0.026 | <0.0002 | 0.0002 | <0.0002 | 420 | 460 | 2.4 | 0.005 |
| Hg | mg/L | 0.01/0.0005 | <0.010 | <0.010 | <0.010 | <0.0005 | <0.0005 | <0.0005 | <0.005 | <0.005 | <0.005 | <0.005 |
| Mo | mg/L | 0.0001 | 0.021 | 0.02 | 0.022 | 0.0006 | 0.0007 | <0.0001 | 0.003 | 0.002 | 0.001 | <0.001 |
| Ni | mg/L | 0.0005 | 0.06 | 0.036 | 0.015 | 0.0013 | <0.0005 | <0.0005 | 6.9 | 7.3 | 0.015 | <0.005 |
| K | mg/L | 0.05 | 730 | 730 | 750 | 0.14 | 0.15 | <0.05 | <0.5 | <0.5 | <0.5 | <0.5 |
| Se | mg/L | 0.01/0.0005 | <0.010 | 0.02 | 0.012 | <0.0005 | <0.0005 | <0.0005 | 0.043 | 0.056 | <0.005 | <0.005 |
| Si | mg/L | 0.05 | 6 | 7 | <5 | <0.05 | <0.05 | <0.05 | 110 | 110 | 4.1 | 3.3 |
| Ag | mg/L | 0.0016/0.00008 | <0.0016 | <0.0016 | <0.0016 | <0.00008 | <0.00008 | <0.00008 | <0.0008 | <0.0008 | <0.0008 | <0.0008 |
| Na | mg/L | 0.02 | 1300 | 1300 | 1400 | 0.23 | 0.27 | <0.02 | 1.1 | 1 | 0.6 | 0.4 |
| S | mg/L | 0.5 | 650 | 600 | 420 | 180 | 210 | <0.5 | 410 | 380 | <5 | <5 |
| W | mg/L | 0.002/0.0001 | <0.002 | <0.002 | <0.002 | <0.0001 | <0.0001 | <0.0001 | <0.001 | <0.001 | <0.001 | <0.001 |
| U | mg/L | 0.001/0.00005 | <0.0010 | <0.0010 | <0.0010 | <0.00005 | <0.00005 | <0.00005 | 0.053 | 0.048 | 0.001 | 0.0009 |
| Zn | mg/L | 0.001 | 0.45 | 0.46 | 0.04 | 0.015 | 0.02 | <0.001 | 3200 | 3400 | 19 | 0.08 |

Source: Z:\01_SITES\Faro\!101_Investigations\2020_WTP_SludgeCharacterization\3. Working Files\[Faro Sludge_WorkingFiguresandTables_1CA030.025_Rev00.xlsx]

Notes

All values provided in two significant figures

**Table 5-8: Sequential Extraction Results - Percent Recovery by Fraction**

| Parameter | Step-1: Exchangeable | | Step-2: Water Soluble | | Step-3: Reducible | | |
|---|---|---|---|---|---|---|---|
| | Extraction 1 | Duplicate Extraction | Extraction 1 | Duplicate Extraction | Extraction 1 | Duplicate Extraction Cycle 1 | Duplicate Extraction Cycle 2 |
| Al | <MDL | 0% | <MDL | <MDL | 62% | 56% | 3% |
| Sb | <MDL | <MDL | <MDL | <MDL | 40% | 40% | <MDL |
| As | 0% | 0% | <MDL | <MDL | 67% | 71% | 29% |
| Cd | 1% | 1% | 0% | 0% | 78% | 86% | 0% |
| Ca | 0% | 0% | 21% | 23% | 59% | 57% | 1% |
| Cr | <MDL | <MDL | <MDL | <MDL | 4% | 5% | 0% |
| Co | 0% | <MDL | <MDL | <MDL | 77% | 80% | 0% |
| Cu | <MDL | 0% | 1% | 1% | 96% | 90% | 4% |
| Fe | <MDL | <MDL | 0% | 0% | 79% | 80% | 1% |
| Pb | <MDL | <MDL | <MDL | <MDL | 86% | 75% | 8% |
| Mg | 16% | 17% | 2% | 2% | 65% | 65% | 0% |
| Mn | 0% | 0% | <MDL | 0% | 77% | 84% | 0% |
| Hg | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| Mo | 0% | 0% | 60% | 70% | 120% | 80% | 40% |
| Ni | 1% | 0% | 0% | <MDL | 88% | 93% | 0% |
| K | 0% | 0% | 20% | 21% | <MDL | <MDL | <MDL |
| Se | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| Si | 3% | 4% | <MDL | <MDL | 56% | 56% | 0% |
| Ag | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| Na | 0% | 0% | 39% | 46% | 48% | 41% | 14% |
| S | 17% | 13% | 33% | 38% | 30% | 28% | <MDL |
| W | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| U | <MDL | <MDL | <MDL | <MDL | 77% | 69% | 0% |
| Zn | 0% | 0% | 0% | 0% | 86% | 92% | 1% |

Source: Z:\01_SITES\Faro\!101_Investigations\2020_WTP_SludgeCharacterization\3. Working Files\[Faro Sludge_WorkingFiguresandTables_1CA030.025_Rev00.xlsx]

Notes

All Values Provided in Two Significant Figures

<MDL indicates parameter below method detection limit in either extraction leachate or sludge solids sample

## 5.7 Aging Tests

### 5.7.1 Oxic Aging Tests

Data for the oxic aging tests in summarized in Table 5-9 with the full set of analytical data provided in Appendix C and timeseries charts for each parameter provided in Appendix E. Results from the raw water used in each aging test variation are included in Table 5-9 as the initial (T0) result for reference. Based on observations, once the test solution was added, the sludge settled and stayed at the bottom of the bottle after initial homogenization.

For the oxic aging tests, the sludge buffered the pH of each test solution to neutral pH in the range of 7.6 to 7.7 by week two or month two (the Vangorda pit water variation). Once at neutral pH, the test solutions maintained pH conditions in the range of 6.5 to 7.8 for the duration of testing (7 months; Figure 5-4). Eh covered a range of oxidizing conditions from 0.34 to 0.59 and did not show any consistent trends with time (Figure 5-6). Electrical conductivity (EC) ranged from 1500 to 5100 µS/cm and showed an increasing trend to month three that levelled off but still showed slight increases with time in each aging test variation (Figure 5-5).

Acidity was measured at low levels (i.e. <5 mg/L as $CaCO_3$) throughout the duration of both tests conducted with de-ionized water, likely reflecting low levels of carbonic acid caused by equilibration with atmospheric $CO_2$. Within the variations conducted with Faro and Vangorda pit water, acidity showed a decreasing trend until reaching low levels by month two progressive buffering by the sludges. Alkalinity was consistently detected in the range of 17 to 48 mg/L as $CaCO_3$ for all four aging test variations and did not show any consistent trends, other than the addition of alkalinity to the Vangorda pit water oxic aging test following reaction with the sludge.

Similar to the SFE leachate results (Section 5.6.1) sulphate (2200 to 4200 mg/L) was the dominant anion in the aging test solutions, while calcium (290 to 480 mg/L) and magnesium (290 to 740 mg/L) were the dominant cations. Chloride and fluoride (<2 mg/L) and sodium and potassium (<30 mg/L) showed low concentrations and did not exhibit any trends with time. Sulphate (Figure 5-7), calcium, and magnesium (Table 5-9) showed similar trends to EC with increasing trends to month three and then slight increases with time in each aging test variation.

Ammonia (1.0 to 1.7 mg/L as N) was the dominant nitrogen form in all four oxic aging test variations and did not show any consistent trends with time. Nitrate and nitrate were consistently measured in low concentrations (i.e. <0.5 mg/L as N) and did not shown any consistent trends, except for the Vangorda pit water variation which showed a slight increase in nitrate and nitrite concentrations over the period of testing. Indeed, a decrease in ammonia concentrations in the Vangorda pit water in parallel with an increase in nitrate and nitrite indicates low rates of microbial nitrification (ammonium oxidation to nitrite or nitrate) at less than 0.005 N-mg/L/d. The other tests did not exhibit the same reactions.

Similar to the SFE leachate results (Section 5.6.1), zinc (0.059 to 26 mg/L) and manganese (0.0024 to 29 mg/L) were the dominant trace elements within the oxic aging test solutions. Both parameters showed slight increasing trends (Figure 5-8 and Figure 5-9) that stabilized by month three in the test variations conducted with de-ionized water and significant (i.e. greater than one order of magnitude) decreasing trends in the test variations conducted with pit water.

The majority of trace elements including antimony, arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, and selenium showed near or below detection limit results. Concentrations of these elements showed either stable (antimony, mercury, molybdenum and selenium) or decreasing (cadmium, chromium, cobalt, copper, lead, and nickel) trends reflecting decreased solubility with progressive buffering by the sludges. Arsenic showed slight increasing trends in the later stages of testing, but concentrations remained less than ten times the detection limit.

Overall, interaction of the sludge with the test solutions under oxic conditions over seven months resulted in buffering the test solutions to neutral pH, loadings of sulphate, calcium, and magnesium to the test solutions, and attenuation of zinc and manganese from the pit water solutions.

**Table 5-9: Summary of Oxic Aging Tests**

| Parameter | | De-Ionized Water pH 4 | | | | | De-Ionized Water pH 7 | | | | | Faro Pit Water | | | | | Vangorda Pit Water | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Week or Month | | Blank (T0) | 2-week | 2-month | 4-month | 7-month | Blank (T0) | 2-week | 2-month | 4-month | 7-month | Blank (T0) | 2-week | 2-month | 4-month | 7-month | Blank (T0) | 2-week | 2-month | 4-month | 7-month |
| pH | | 4.1 | 7.5 | 7.7 | 6.4 | 6.1 | 7.1 | 7.7 | 7.7 | 7.1 | 6.5 | 6.9 | 7.5 | 7.8 | 7.2 | 6.4 | 3.6 | 5.7 | 7.6 | 7.2 | 6.5 |
| Eh | V | 0.59 | 0.44 | 0.46 | 0.45 | 0.44 | 0.43 | 0.43 | 0.47 | 0.45 | 0.44 | 0.34 | 0.43 | 0.46 | 0.44 | 0.44 | 0.5 | 0.47 | 0.47 | 0.44 | 0.43 |
| EC | uS/cm | 56 | 1500 | 3400 | 3600 | 3800 | 12 | 1700 | 2900 | 3500 | 3700 | 1900 | 2800 | 3800 | 4300 | 4700 | 2700 | 3300 | 4000 | 4700 | 5100 |
| Acidity | mg $CaCO_3$/L | | <0.5 | <0.5 | 5 | 4.2 | | <0.5 | <0.5 | 5 | 3.7 | 66 | 8.5 | <0.5 | 5 | 3.4 | 560 | 68 | <0.5 | 3.3 | 2.4 |
| Alkalinity | mg $CaCO_3$/L | | 27 | 23 | 18 | 19 | | 23 | 27 | 18 | 19 | 48 | 48 | 35 | 18 | 19 | <0.5 | 27 | 22 | 17 | 17 |
| Sulphate | mg/L | | 2200 | 2400 | 2900 | 2900 | | 2100 | 2400 | 2800 | 3100 | 1200 | 2900 | 3100 | 3400 | 3500 | 1900 | 3500 | 3300 | 4100 | 4200 |
| Chloride | mg/L | | 0.5 | 0.7 | 0.6 | 0.6 | | 0.6 | 0.5 | 0.7 | 0.8 | 1.3 | 2.2 | 1.9 | 1.7 | 1.6 | 0.58 | 1.4 | 1 | 1 | 1.1 |
| Fluoride | mg/L | | 0.3 | <0.2 | <0.2 | <0.2 | | 0.3 | <0.2 | <0.2 | <0.2 | 0.48 | 0.5 | 0.5 | 0.2 | 0.5 | 0.48 | 0.6 | <0.2 | 0.3 | 0.34 |
| Nitrate (as N) | mg/L | | <0.05 | <0.05 | <0.05 | <0.05 | | 0.05 | <0.05 | <0.05 | <0.05 | 0.19 | 0.41 | 0.24 | 0.2 | 0.17 | 0.1 | 0.17 | 0.18 | 0.21 | 0.23 |
| Nitrite (as N) | mg/L | | 0.08 | 0.08 | 0.13 | 0.1 | | 0.13 | 0.11 | 0.12 | 0.1 | <0.005 | 0.12 | 0.2 | 0.13 | 0.1 | 0.028 | 0.13 | 0.2 | 0.16 | 0.2 |
| Ammonia (as N) | mg/L | | 1.3 | 1 | 1.1 | 1 | | 1.3 | 1.1 | 1 | 1 | 1.5 | 1.7 | 1.8 | 1.6 | 1.5 | 0.39 | 2 | 1.8 | 1.3 | 1.1 |
| Sb | mg/L | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| As | mg/L | | <0.0002 | <0.0002 | 0.001 | 0.002 | | <0.0002 | <0.0002 | 0.0008 | 0.0011 | 0.0003 | <0.0002 | <0.0002 | 0.0008 | 0.0011 | 0.0014 | 0.0004 | <0.0002 | 0.0007 | 0.0011 |
| Cd | mg/L | | 0.00007 | 0.00009 | 0.00012 | 0.00012 | | 0.00007 | 0.00015 | 0.0001 | 0.00022 | 0.011 | 0.00084 | 0.0003 | 0.00017 | 0.00019 | 0.079 | 0.024 | 0.011 | 0.001 | 0.00094 |
| Ca | mg/L | | 290 | 340 | 460 | 480 | | 290 | 360 | 440 | 480 | 210 | 360 | 400 | 440 | 460 | 230 | 390 | 430 | 440 | 460 |
| Cr | mg/L | | 0.001 | <0.0005 | 0.0006 | 0.0009 | | 0.0007 | <0.0005 | 0.0007 | 0.0009 | <0.0005 | <0.0005 | <0.0005 | 0.0011 | 0.0016 | <0.0005 | 0.0015 | <0.0005 | 0.002 | 0.003 |
| Co | mg/L | | 0.0003 | 0.0007 | 0.0009 | 0.0008 | | 0.0011 | 0.0009 | 0.0013 | 0.0019 | 0.11 | 0.0083 | 0.005 | 0.0025 | 0.0062 | 0.6 | 0.2 | 0.15 | 0.0023 | 0.0019 |
| Cu | mg/L | | <0.0005 | 0.0006 | <0.0005 | <0.0005 | | <0.0005 | <0.0005 | 0.0014 | 0.0018 | 0.0013 | <0.0005 | 0.0005 | 0.0009 | 0.0014 | 0.3 | 0.0024 | 0.0014 | 0.0008 | 0.0009 |
| Fe | mg/L | | <0.02 | <0.02 | <0.02 | <0.02 | | <0.02 | <0.02 | <0.02 | <0.02 | 0.27 | <0.02 | <0.02 | <0.02 | <0.02 | 110 | <0.02 | <0.02 | <0.02 | <0.02 |
| Pb | mg/L | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | 0.072 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Mg | mg/L | | 290 | 410 | 450 | 470 | | 290 | 400 | 450 | 460 | 110 | 460 | 540 | 580 | 590 | 150 | 540 | 640 | 710 | 740 |
| Mn | mg/L | | 0.0024 | 0.0034 | 0.0042 | 0.0055 | | 0.0064 | 0.014 | 0.015 | 0.018 | 12 | 4 | 0.91 | 0.079 | 0.073 | 49 | 29 | 17 | 0.005 | 0.013 |
| Hg | mg/L | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Mo | mg/L | | 0.0005 | 0.0003 | 0.0003 | 0.0003 | | 0.0003 | 0.0003 | 0.0003 | 0.0005 | <0.0001 | 0.0002 | 0.0003 | 0.0002 | 0.0002 | 0.0005 | 0.0002 | 0.0003 | 0.0003 | 0.0004 |
| Ni | mg/L | | <0.0005 | 0.0012 | 0.0009 | 0.0016 | | <0.0005 | 0.0014 | 0.0016 | 0.0021 | 0.19 | 0.014 | 0.0066 | 0.0034 | 0.0029 | 0.46 | 0.13 | 0.085 | 0.0021 | 0.0019 |
| K | mg/L | | 1.4 | 1.6 | 1.6 | 1.6 | | 1.4 | 1.5 | 1.6 | 1.7 | 9.7 | 12 | 12 | 11 | 12 | 3 | 4.7 | 4.6 | 4.9 | 5.1 |
| Se | mg/L | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | 0.0021 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | 0.0043 | 0.0028 | <0.0005 | <0.0005 | <0.0005 |
| Na | mg/L | | 3.8 | 4.5 | 5 | 5.3 | | 5.8 | 6.1 | 6.8 | 7.1 | 24 | 28 | 28 | 29 | 29 | 7.6 | 11 | 12 | 13 | 14 |
| Zn | mg/L | | 0.059 | 0.19 | 0.14 | 0.21 | | 0.089 | 0.19 | 0.36 | 0.41 | 33 | 0.45 | 0.47 | 0.24 | 0.22 | 160 | 26 | 15 | 0.32 | 0.28 |

Source: Z:\01_SITES\Faro\!101_Investigations\2020_WTP_SludgeCharacterization\3. Working Files\[Faro Sludge _AgingTestWorkingFile_JED_spinner_Rev01.xlsx]

Notes:

T0 for the aging tests using pit water shows initial pit water concentrations prior to addition of sludge

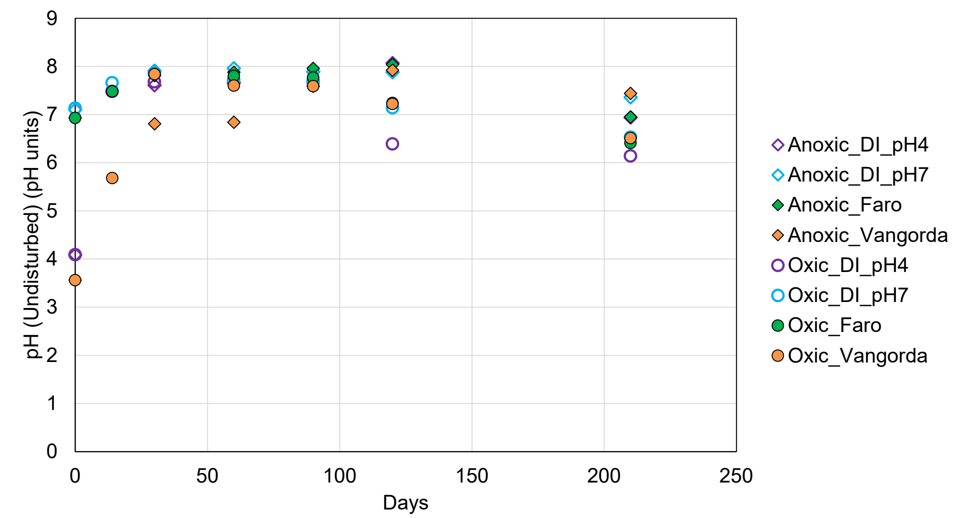


**Figure 5-4: pH vs Time; Oxic and Anoxic Aging Tests**

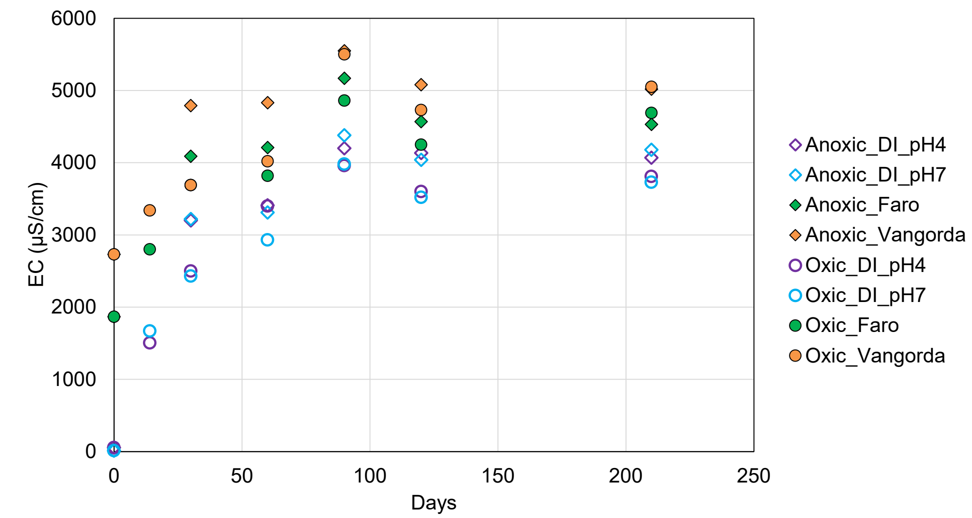


**Figure 5-5: EC vs Time; Oxic and Anoxic Aging Tests**

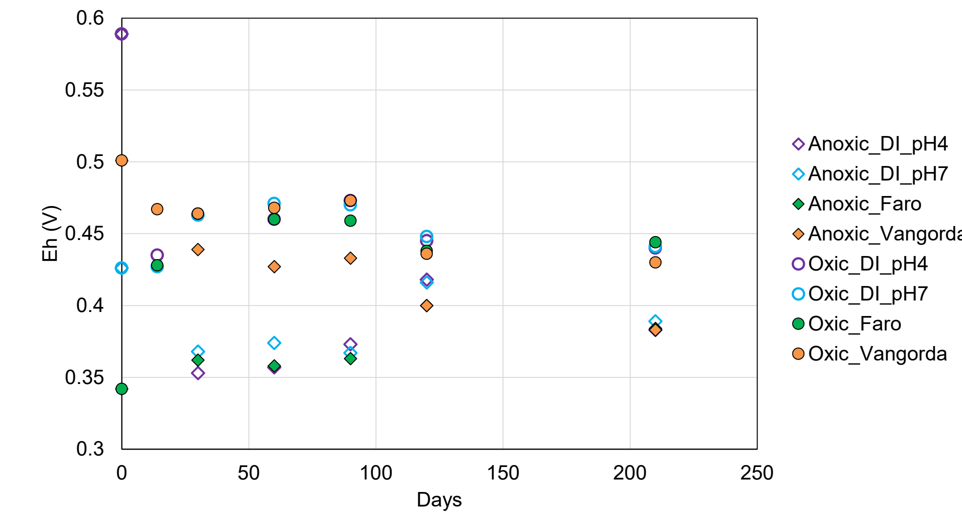


**Figure 5-6: Eh vs Time; Oxic and Anoxic Aging Tests**

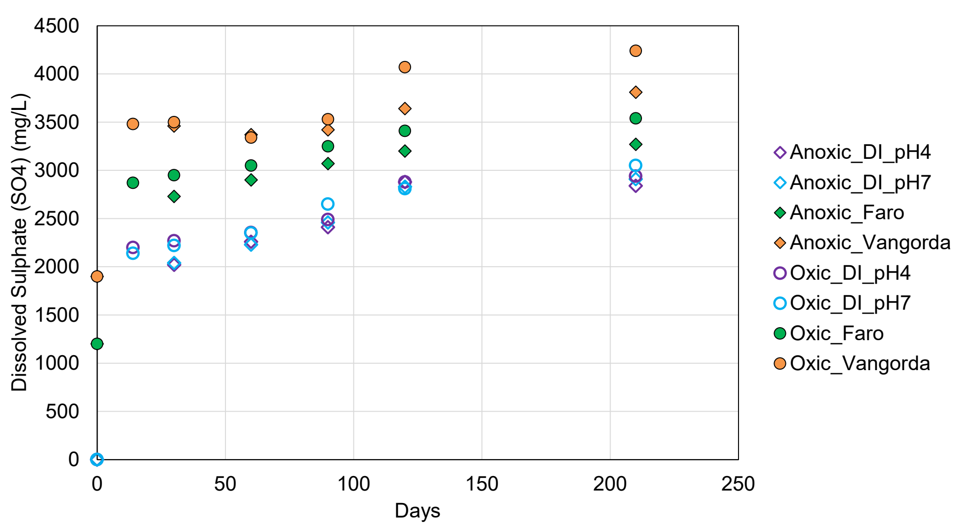


**Figure 5-7: Dissolved Sulphate vs Time; Oxic and Anoxic Aging Tests**

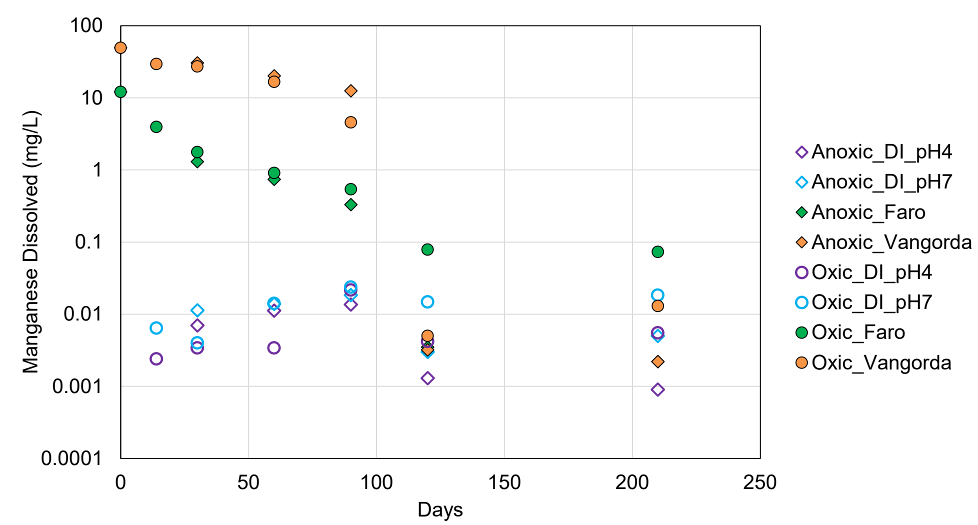


**Figure 5-8: Dissolved Manganese vs Time; Oxic and Anoxic Aging Tests**

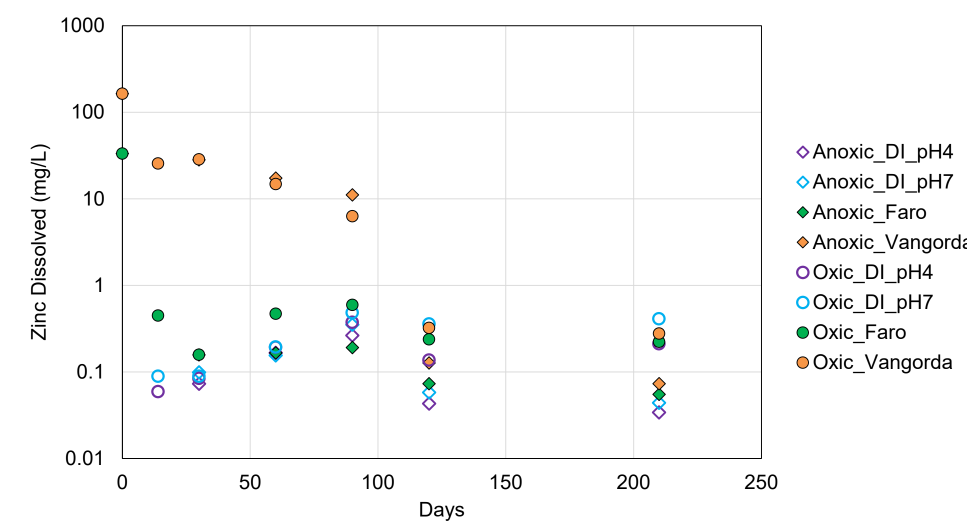


**Figure 5-9: Dissolved Zinc vs Time; Oxic and Anoxic Aging Tests**

### 5.7.2 Anoxic Aging Tests

Data for the anoxic aging tests in summarized in Table 5-10 with the full set of analytical data provided in Appendix C and timeseries charts for each parameter provided in Appendix E. Results from the raw water used in each aging test variation are included in Table 5-10 as the initial (T0) result for reference.

For the anoxic aging tests, the sludge buffered the pH of each test solution to neutral pH by the first sample session (2-months). Once neutral conditions were reached, pH conditions were maintained in the range of 6.8 to 8.1 for the duration of testing (7 months; Figure 5-4). The Eh and dissolved oxygen concentration of the test solutions remained relatively stable and ranged from 0.34 to 0.59 V and 0.1 to 0.5 mg/L respectively reflecting a range of anoxic and slightly reducing conditions. Despite the abundant dissolved carbon (301 to 440 mg/L) and maintenance of anoxic conditions the test solutions did not reach the range of Eh conditions (0.19 to 0.28 V) observed within the bottom of the Faro Pit Lake in 2008 when meromixis was established. Levels of total and dissolved organic carbon remained greater than 290 mg/L, showing low consumption rates of carbon relative to the 300 mg/L dosage added at the beginning of the tests.

EC, alkalinity, acidity, and major ions showed similar levels and trends as the oxic aging tests. Iron, manganese, and zinc showed lower concentrations within the anoxic tests relative to the oxic tests indicating reductive dissolution was not occurring over the range of Eh conditions measured.

Ammonia (1.0 to 1.8 mg/L as N) and nitrite (<0.25 mg/L as N) showed similar levels as the oxic aging tests, but nitrate showed a decreasing trend in each of the anoxic test variations and was near the detection limit by month four (Table 5-10) reflecting progressive reduction of nitrate under these Eh conditions. Reduction of nitrate likely indicates microbial denitrification (reduction of nitrate to nitrite or nitrogen gas) under anoxic conditions. However, the rates achieved in the anoxic tests remained low, with a maximum of 0.003 N mg/L/d. This is in line with the fact that the levels of carbon added to the tests remained were not consumed indicating a lack of microbial activity, and no sulphate reduction was observed. Therefore, the lack of reducing conditions appears to be due to a combination of slow nitrate reduction and redox buffering from the sludge.

Overall, the interaction with the sludge under reducing conditions similar to those previously observed in the Faro Pit Lake could not be tested as the abundant oxidizing mineral phases within the sludge limited the development of reducing conditions within the time frame of the tests. Under the conditions tested, which reflect anoxic and slightly reducing waters (confirmed by slight reduction of nitrate), interaction of the sludge with the test solutions over seven months resulted in buffering of the test solutions to neutral pH, loadings of sulphate, calcium, and magnesium to the test solutions, and attenuation of zinc and manganese from the pit water solutions.

**Table 5-10: Summary of Anoxic Aging Test Data**

| Parameter | | Anoxic De-Ionized Water pH 4 | | | | Anoxic De-Ionized Water pH 7 | | | | Anoxic Faro Pit Water | | | | Anoxic Vangorda Pit Water | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Week or Month | | Blank (T0) | 2-month | 4-month | 7-month | Blank (T0) | 2-month | 4-month | 7-month | Blank (T0) | 2-month | 4-month | 7-month | Blank (T0) | 2-month | 4-month | 7-month |
| pH | | 4.1 | 7.7 | 8.1 | 6.9 | 7.1 | 8 | 7.9 | 7.4 | 6.9 | 7.9 | 8 | 7 | 3.6 | 6.8 | 7.9 | 7.4 |
| Eh | V | 0.59 | 0.36 | 0.42 | 0.38 | 0.43 | 0.37 | 0.42 | 0.39 | 0.34 | 0.36 | 0.4 | 0.38 | 0.5 | 0.43 | 0.4 | 0.38 |
| EC | uS/cm | 56 | 3400 | 4100 | 4100 | 12 | 3300 | 4000 | 4200 | 1900 | 4200 | 4600 | 4500 | 2700 | 4800 | 5100 | 5000 |
| Dissolved Oxygen | mg/L | 0.06 | 0.5 | 0.4 | 0.3 | 0.11 | 0.3 | 0.4 | 0.2 | 9.2 | 0.3 | 0.2 | 0.3 | 8.5 | 0.3 | 0.2 | 0.3 |
| Acidity | mg $CaCO_3$/L | | <0.5 | <0.5 | 0.6 | | <0.5 | <0.5 | 0.5 | 66 | <0.5 | <0.5 | 0.5 | 560 | 45 | <0.5 | 0.5 |
| Alkalinity | mg $CaCO_3$/L | | 20 | 18 | 17 | | 22 | 15 | 16 | 48 | 36 | 17 | 17 | <0.5 | 14 | 17 | 17 |
| Sulphate | mg/L | | 2300 | 2900 | 2800 | | 2200 | 2800 | 2900 | 1200 | 2900 | 3200 | 3300 | 1900 | 3400 | 3600 | 3800 |
| Chloride | mg/L | | 2 | 0.6 | 0.9 | | 1.2 | 0.5 | <0.5 | 1.3 | 1.8 | 1.7 | 1.6 | 0.58 | 1 | 1.8 | 1.6 |
| Fluoride | mg/L | | <0.2 | <0.2 | <0.2 | | <0.2 | <0.2 | <0.2 | 0.48 | <0.2 | 0.2 | 0.2 | 0.48 | 0.2 | 0.3 | 0.3 |
| Nitrate (as N) | mg/L | | 1.4 | <0.05 | <0.05 | | <0.05 | <0.05 | <0.05 | 0.19 | 0.27 | 0.05 | <0.05 | 0.1 | 0.19 | <0.05 | <0.05 |
| Nitrite (as N) | mg/L | | 0.12 | 0.13 | 0.11 | | 0.13 | 0.11 | 0.08 | <0.005 | 0.1 | 0.24 | 0.1 | 0.028 | 0.16 | 0.24 | 0.22 |
| Ammonia (as N) | mg/L | | 1.2 | 1 | 1.1 | | 1 | 1.1 | 1 | 1.5 | 1.8 | 1.5 | 1.3 | 0.39 | 1.7 | 1.3 | 1 |
| Sb | mg/L | | 0.0002 | <0.0001 | <0.0001 | | 0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| As | mg/L | | <0.0002 | 0.0007 | 0.0011 | | <0.0002 | 0.0009 | 0.0012 | 0.0003 | <0.0002 | 0.0012 | 0.0019 | 0.0014 | 0.0002 | 0.0009 | 0.0011 |
| Cd | mg/L | | 0.00015 | 0.00009 | 0.00006 | | 0.00017 | 0.00017 | 0.00013 | 0.011 | 0.00031 | 0.00018 | 0.00012 | 0.079 | 0.024 | 0.00085 | 0.00077 |
| Ca | mg/L | | 320 | 450 | 440 | | 340 | 430 | 450 | 210 | 390 | 460 | 490 | 230 | 410 | 460 | 480 |
| Cr | mg/L | | <0.0005 | 0.0015 | 0.002 | | <0.0005 | 0.0008 | 0.001 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Co | mg/L | | 0.0006 | 0.0006 | 0.0007 | | 0.0009 | 0.0005 | 0.0005 | 0.11 | 0.004 | 0.001 | 0.001 | 0.6 | 0.12 | 0.0017 | 0.0013 |
| Cu | mg/L | | <0.0005 | 0.0013 | 0.0016 | | <0.0005 | 0.0007 | 0.0009 | 0.0013 | <0.0005 | 0.0014 | 0.0019 | 0.3 | 0.0025 | 0.001 | 0.001 |
| Fe | mg/L | | <0.02 | <0.02 | <0.02 | | <0.02 | <0.02 | <0.02 | 0.27 | <0.02 | <0.02 | <0.02 | 110 | <0.02 | <0.02 | <0.02 |
| Pb | mg/L | | <0.0005 | <0.0005 | <0.0005 | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | 0.072 | <0.0005 | <0.0005 | <0.0005 |
| Mg | mg/L | | 380 | 440 | 430 | | 390 | 450 | 470 | 110 | 510 | 560 | 580 | 150 | 610 | 680 | 700 |
| Mn | mg/L | | 0.011 | 0.0013 | 0.0009 | | 0.014 | 0.003 | 0.005 | 12 | 0.74 | 0.0035 | 0.0022 | 49 | 20 | 0.0032 | 0.0022 |
| Hg | mg/L | | <0.0005 | <0.0005 | <0.0005 | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Mo | mg/L | | 0.0004 | 0.0002 | 0.0002 | | 0.0002 | 0.0003 | 0.0002 | <0.0001 | 0.0001 | 0.0002 | 0.0002 | 0.0005 | 0.0001 | 0.0002 | 0.0002 |
| Ni | mg/L | | 0.0008 | 0.0011 | 0.002 | | 0.0011 | <0.0005 | <0.0005 | 0.19 | 0.0044 | 0.0011 | 0.0009 | 0.46 | 0.076 | 0.0013 | 0.0009 |
| K | mg/L | | 1.9 | 1.5 | 1.2 | | 2.1 | 1.6 | 1.3 | 9.7 | 11 | 11 | 9.7 | 3 | 4.2 | 4.3 | 4.5 |
| Se | mg/L | | <0.0005 | <0.0005 | <0.0005 | | <0.0005 | <0.0005 | <0.0005 | 0.0021 | <0.0005 | <0.0005 | <0.0005 | 0.0043 | 0.0022 | 0.0006 | <0.0005 |
| Na | mg/L | | 5.7 | 7.1 | 7.8 | | 6.1 | 5.4 | 5.1 | 24 | 27 | 27 | 26 | 7.6 | 12 | 13 | 12 |
| Zn | mg/L | | 0.17 | 0.043 | 0.034 | | 0.16 | 0.058 | 0.044 | 33 | 0.17 | 0.073 | 0.055 | 160 | 17 | 0.13 | 0.073 |

Source: Z:\01_SITES\Faro\!101_Investigations\2020_WTP_SludgeCharacterization\3. Working Files\[Faro Sludge _AgingTestWorkingFile_JED_spinner_Rev01.xlsx]

Notes:

T0 for the aging tests using pit water shows initial pit water concentrations

### 5.7.3 Aging Test Loadings

To interpret the chemical loadings of the sludge to the aging test solutions, loadings were calculated for the duration of testing (i.e. total load contributed to the test solution by month seven) using the method described in Section 5.6.1. Parameters which decreased in concentration upon reaction with the sludge exhibit negative loadings. The resulting summary of the aging test loadings for selected parameters is presented in Table 5-11. The results are discussed as follows:

- Similar to the SFEs, the sludge contributed significant loadings of sulphate (36,000 to 58,000 mg/kg), calcium (4700 to 9200 mg/kg) and magnesium (8200 to 11,000) to the aging test solutions.
- Eh conditions did not appear to have a strong control on leaching and most parameters showed similar loadings between the oxic and anoxic aging tests except cadmium, manganese, nickel, and zinc which showed higher loadings under oxic conditions.
- Similar to the SFE loadings, interaction within the pit water solutions and the sludge resulted in attenuation of cobalt, iron, lead, manganese, nickel selenium, and zinc.
- Loadings of sulphate, chloride, arsenic cadmium, chromium, cobalt, copper, magnesium, manganese, nickel, potassium sodium, and zinc were higher in the oxic aging test variations conducted with DI water (Figure 5-11) relative to the SFE loadings (Figure 5-11) reflecting continued leaching of these parameters over the longer time frame of testing.
- Overall, the sludges contributed the highest loadings of calcium, magnesium, and sulphate to the test solutions and resulted in the highest levels of attenuation of iron, manganese, and zinc concentrations from the pit water solutions.

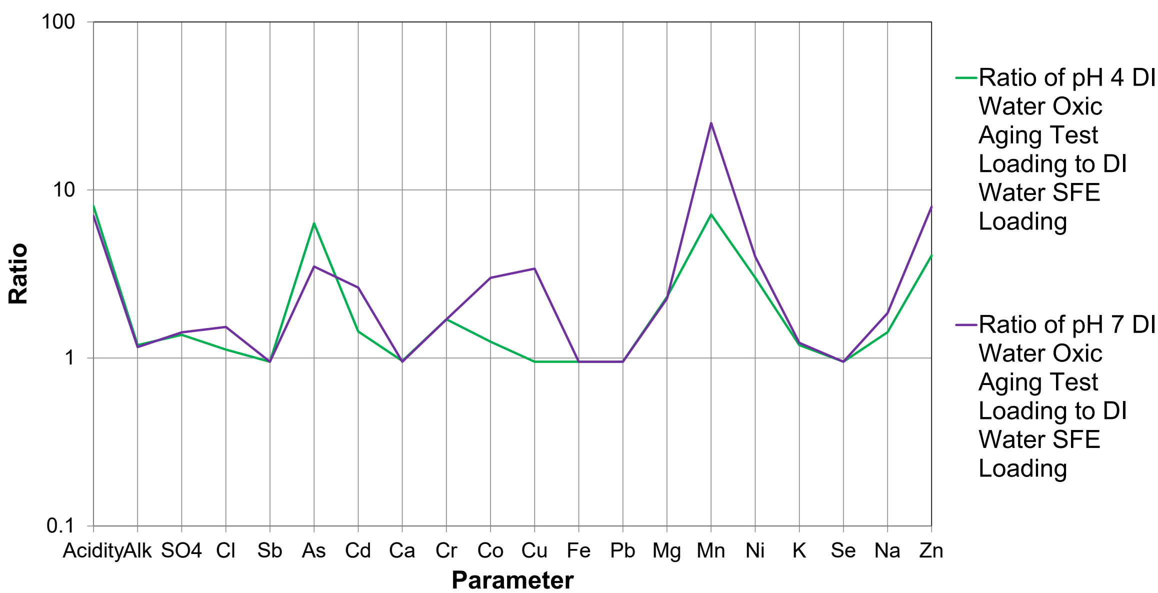


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**Figure 5-10: Ratio of DI Water Oxic Aging Test Loadings to DI Water SFE Loadings**

**Table 5-11: Summary of Aging Test Loadings**

| Parameter | | Oxic Aging Tests | | | | Anoxic Aging Tests | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | De-Ionized Water pH 4 | De-Ionized Water pH 7 | Faro Pit Water | Vangorda Pit Water | De-Ionized Water pH 4 | De-Ionized Water pH 7 | Faro Pit Water | Vangorda Pit Water |
| Acidity | mg $CaCO_3$/kg | 80 | 70 | -1000 | -10000 | 11 | 9.5 | -1000 | -10000 |
| Alkalinity | mg $CaCO_3$/kg | 370 | 360 | -600 | 320 | 320 | 310 | -600 | 320 |
| Sulphate | mg/kg | 56000 | 58000 | 44000 | 44000 | 54000 | 55000 | 39000 | 36000 |
| Chloride | mg/kg | 11 | 15 | 5.7 | 9.9 | 17 | <9.5 | 5.7 | 19 |
| Fluoride | mg/kg | <3.8 | <3.8 | 0.38 | -3 | <3.8 | <3.8 | -5 | -3 |
| Nitrate (as N) | mg/kg | <0.95 | <0.95 | -0.3 | 2.5 | <0.95 | <0.95 | -3 | <0.95 |
| Nitrite (as N) | mg/kg | 1.9 | 1.9 | 1.8 | 3.3 | 2.1 | 1.5 | 1.8 | 3.6 |
| Ammonia (as N) | mg/kg | 19 | 19 | -0.6 | 13 | 20 | 19 | -4 | 12 |
| Sb | mg/kg | <0.0019 | <0.0019 | <0.0019 | <0.0019 | <0.0019 | <0.0019 | <0.0019 | <0.0019 |
| As | mg/kg | 0.038 | 0.021 | 0.015 | -0.006 | 0.021 | 0.023 | 0.03 | -0.006 |
| Cd | mg/kg | 0.0023 | 0.0042 | -0.2 | -1 | 0.0011 | 0.0025 | -0.2 | -1 |
| Ca | mg/kg | 9200 | 9100 | 4700 | 4300 | 8400 | 8500 | 5300 | 4900 |
| Cr | mg/kg | 0.017 | 0.017 | 0.021 | 0.048 | 0.038 | 0.019 | <0.0095 | <0.0095 |
| Co | mg/kg | 0.015 | 0.036 | -2 | -10 | 0.013 | 0.0095 | -2 | -10 |
| Cu | mg/kg | <0.0095 | 0.034 | 0.0019 | -6 | 0.03 | 0.017 | 0.011 | -6 |
| Fe | mg/kg | <0.38 | <0.38 | -5 | -2000 | <0.38 | <0.38 | -5 | -2000 |
| Pb | mg/kg | <0.0095 | <0.0095 | <0.0095 | -1 | <0.0095 | <0.0095 | <0.0095 | -1 |
| Mg | mg/kg | 9000 | 8800 | 9200 | 11000 | 8200 | 8900 | 8900 | 11000 |
| Mn | mg/kg | 0.1 | 0.35 | -200 | -900 | 0.017 | 0.095 | -200 | -900 |
| Hg | mg/kg | <0.0095 | <0.0095 | <0.0095 | <0.0095 | <0.0095 | <0.0095 | <0.0095 | <0.0095 |
| Mo | mg/kg | 0.0057 | 0.0095 | 0.0019 | -0.002 | 0.0038 | 0.0038 | 0.0019 | -0.006 |
| Ni | mg/kg | 0.03 | 0.04 | -3 | -9 | 0.038 | 0.0095 | -3 | -9 |
| K | mg/kg | 31 | 32 | 35 | 40 | 23 | 25 | -0.8 | 28 |
| Se | mg/kg | <0.0095 | <0.0095 | -0.03 | -0.07 | <0.0095 | <0.0095 | -0.03 | -0.07 |
| Na | mg/kg | 100 | 130 | 110 | 110 | 150 | 97 | 55 | 91 |
| Zn | mg/kg | 4 | 7.8 | -600 | -3000 | 0.65 | 0.84 | -600 | -3000 |

Source: Z:\01_SITES\Faro\!101_Investigations\2020_WTP_SludgeCharacterization\3. Working Files\[Faro Sludge _AgingTestWorkingFile_JED_spinner_Rev01.xlsx]

# 6 Discussion

The analysis of the sludge composition found that the most abundant elements within the sludge were zinc, calcium, magnesium, iron, sulphur, and manganese and that the sludge was comprised dominantly of oxy-hydroxides or more complex layered hydroxides (collectively referred to as O-phases), gypsum, and carbonates. Zinc is dominantly hosted within the array of O-phases and also to a lesser degree within zinc and manganese oxides.

Short and long-term leach tests have quantified the water-soluble fraction within the sludge under neutral and acidic conditions across a range of Eh conditions ranging from oxidizing to slightly reducing to strongly reducing. These tests have determined that the sludge will contribute significant loadings of calcium, magnesium, and sulphate under neutral conditions to both acidic and non-acidic pit water reflecting leaching of gypsum, O-phases, and carbonate minerals. Based on the significant loadings of calcium and magnesium, loadings of these parameters are expected to be released until the gypsum saturation limit is reached within the pit lake. The release of magnesium may further increase the concentrations of sulphate in equilibrium with gypsum due to common ion effects. Higher sulphate concentrations in the pit lake may result in higher sulphate concentrations in treated effluent from the water treatment plant.

The sludge also is also expected to contribute lesser loadings of chloride, chromium, nitrate, nitrite, potassium, and sodium across the range of expected disposal conditions. Loadings of antimony, arsenic, silver, mercury, lead, vanadium, and selenium are not expected to be an issue as these parameters were near detection limits in all aging test and extraction test variations. For the remaining pH sensitive elements present within the pit waters as divalent cations (i.e. iron, manganese, zinc) the loadings from the pit lake sludge or attenuation of the pit waters is expected to largely be controlled by the prevalent pH conditions within the pit lake. If the sludge is able to effectively buffer the pH of the pit lake or if the pit lake remains neutral then sludge deposition is expected to result in attenuation of zinc, manganese, and iron and to a lesser degree cobalt, copper, and nickel from the pit lake water column. The current test work program was not able to quantify the stability of the sludge under un-buffered acidic conditions and stability under these conditions remains uncertain.

Results of the laboratory titration determined that the sludge is expected to have a buffering capacity of 2.5 mols $H^+$/L at a pH range above pH 5. Using the volume of the pit lake (29 to 31 million cubic meters) and assuming the pit lake develops a pH of 3.5, the pit lake would contain ($9.5 \times 10^6$) moles of acidity. Using the estimated rate of sludge deposition (25,000 $m^3$/year), the buffering capacity of the sludge deposited each year would represent approximately 6.5 times the total acidity within the pit lake assuming no additional inflows were occurring. Based on this preliminary comparison, sludge deposition would theoretically have an influence on the pH of the pit lake – if the sludges are allowed to mix and react with the pit lake. A more detailed assessment should be completed using the rates of acidic inflows to understand the role of the sludge's buffering capacity.

Results from the reducible step of the sequential extraction indicated that the majority of the trace elements within the sludge are present within reducible phases. The long-term aging tests were not able to fully quantify the stability of the sludge over the expected range of reducing conditions due to the slow rates of microbial reduction. However, the test results did reflect a lack of increased loadings of iron, manganese, and zinc over slightly reducing conditions in the range of 0.34 to 0.59 V. If meromixis were to redevelop, and the sludges don't provide buffering of redox conditions, Eh conditions would likely drop back to levels similar to or lower than those observed in 2008 (0.19 to 0.28 V). Under Eh conditions similar to those observed in 2008 denitrification and reduction of manganese oxides would likely occur, but destabilization of the hydroxide treatment precipitates would be unlikely because the reduction of $Fe^{3+}$ occurs at lower Eh. If the Eh dropped below 2008 levels (i.e. <0.1 Eh), both iron and manganese reduction would occur, and the hydroxide treatment precipitates would likely start to destabilize. In contrast, deposition of sludges may provide buffering of redox conditions, as was observed in the anoxic aging tests. If that occurs, then the Eh conditions in the anoxic tests may be representative of future conditions, and the sludges would remain stable.

Overall, storage of the sludge within the pit lake is expected to bring concentrations of calcium, magnesium, and sulphate to gypsum saturation and result in loadings of chloride, chromium, nitrate, nitrite, potassium, and sodium across the range of expected disposal conditions. The sludge is expected to have a buffering effect on the pH of the pit lake and iron, manganese, and zinc will be attenuated if the pit lake is effectively buffered. Development of reducing conditions within the pit lake is expected to result in result in de-nitrification and reduction of manganese oxides. The degree to which the sludge will interact with the water column remains uncertain and therefore considerations of the impact of sludge deposition should reflect total potential loadings to the pit lake.

# 7 Conclusion

This report presents the results of a laboratory characterization program of the sludge from the Faro high-density sludge pilot plant testing program, and the depositional environment for the sludge. The chemical and mineralogical composition and short and long-term stability of the sludges was tested using solids chemistry, mineralogy, shake-flask extractions, selective extractions, and aging tests.

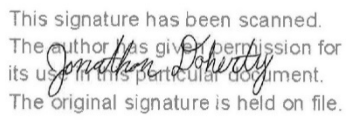
The investigation found the following:

- Sludge Filtrate:
  - Filtrate from the sludge had a slightly alkaline pH of 8.4 with low alkalinity (9.5 mg/L). Cations within the sludge filtrate were dominated by calcium (480 mg/L) and magnesium (170 mg/L) with anions dominated by sulphate (2200 mg/L). The sludge filtrate did not show enrichments in any parameters relative to the Faro pit water and zinc had a notably low concentration of 0.028 mg/L.
- Elemental and mineralogical composition:
  - The methods used could account for 49% of the sludge's dry mass indicating high volatile content. The quantified mass was dominated by zinc (15%), calcium (9.0%), magnesium (7.7%), iron (6.4%), sulphur (5.4%), manganese (2.2%), and carbon (1.5%). Cobalt and nickel were detected at 280 and 310 ppm respectively, while other trace elements had near detection limit or relatively low concentrations.
  - The sludge was composed dominantly of an array of oxy-hydroxide or more complex (i.e. double layered hydroxide) phases which contained variable concentrations of Al, Ca, Fe, Mg, Mn, S, Si, and Zn. The remainder of the sludge was dominantly composed of zinc and manganese oxides, gypsum and carbonates including calcite, ankerite, and dolomite.
- Buffering capacity:
  - The sludge is expected to have the ability to buffer 2.5 mols $H^+$/L at a pH above 5.
- Water-soluble fraction and chemical stability under expected disposal conditions:
  - Under the range of expected conditions, the sludge is expected to contribute loadings of calcium, magnesium, and sulphate to the pit lake. Concentrations of calcium and sulphate are expected to increase until the gypsum saturation limit is reached. Magnesium released from the sludges will result in an increase in the solubility limits for gypsum.
  - The sludge was measured to have detectable levels (i.e. <10 mg/kg) of water-soluble zinc and manganese in tests conducted with de-ionized water; however, attenuation of these elements within tests conducted with pit waters indicate sludge deposition also has potential to reduce concentrations of these constituents within pit waters. The remaining trace elements showed low water-soluble fractions (i.e. <0.5 mg/kg) under neutral pHs across a range of oxidizing to slightly reducing conditions indicating a low potential for leaching.

- Under acidic conditions, the sludge is expected to release elements hosted within carbonates (calcium, magnesium, and alkalinity). The stability of the oxide and hydroxide precipitates under prolonged acidic conditions remains uncertain.
- Under the likely range of reducing conditions should meromixis redevelop, microbial reduction is not expected to reach the iron reduction step and the hydroxide precipitates which host the majority of the trace elements within the sludge would likely be stable. However, the ability of the sludge to buffer Eh within the sludges and the stability of the sludge precipitates under more reducing conditions remains uncertain.

# Closure

This report, Faro Water Treatment Plant Sludge Characterization Report, was prepared by

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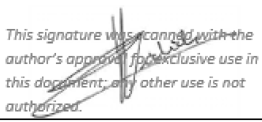


Céline Michiels, PhD
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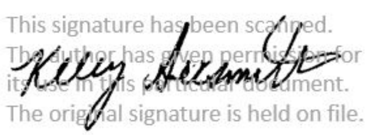
and reviewed by




Kelly Sexsmith, PGeo (BC)
Principal Consultant (Geochemistry)

All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

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# Appendix A: SGS TIMA-X Mineralogy Data

MEMO

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| | |
|---|---|
| To : | Jonathan Doherty |
| From : | Lain Glossop |
| Company : | SRK Consulting (Canada) Inc. (17925-01) |
| Date : | July 06, 2020 Updated February 5, 2021 |
| Copies : | Logan Jameson, Landon Kapusianyk |
| Total pages : | 21 |
| **Re :** | **TIMA Mineralogical Analysis on Faro Sludge sample  Sample** |

This memo summarizes testwork completed by the mineralogy group at SGS in Vancouver, on one sediment sample from SRK Consulting (Canada) Inc.  The objective of this program was to mineralogically characterize the sample by TIMA-X (TESCAN Integrated Mineral Analyser).  All techniques were used to evaluate and report the occurrence of sulphur containing minerals within the sample of Faro Sludge sample.

## 1. Sample Preparation

One sample was provided for the project. The sample was weighed and inventoried, with all information entered into a Laboratory Information Management System (LIMS) with assigned number MI7017-APR20.

The sample was air dried and deagglomerated, then micro-riffled to obtain a ~10 g subsample for major elements by Whole Rock Analysis (WRA) using X-ray Fluorescence (XRF) and total sulphur by LECO Carbon and Sulphur Analyzer (CSA). A further ~10 g subsample was produced to prepare 2x polished section from the sample. The polish was conducted using the dry method, as to retain any water-soluble phases.

## 2. TIMA-X Mineralogy (Alternative Automated Mineralogical Analysis)

TIMA-X is an acronym for TESCAN Integrated Mineral Analyzer which is one of the newest Automated Scanning Electron Microscopy (ASEM) instruments on the market. It is based on four Energy Dispersive X-Ray (EDX) silicon drift detectors (SDD) attached to a TESCAN MIRA (field-emission gun – FEG) platform which also include a backscattered electron (BSE) and secondary electron (SE) detectors. The TIMA system utilizes both the EDX and BSE signals to identify minerals at each measurement point (or each homogenous segment of a grain, depending upon the analysis mode) and it is optimized to deal with rapidly acquired low-count spectra. These EDX (and BSE) spectra (and BSE data) are compared to entries in a mineral library on a first match principle to identify the mineral phase, where this mineral library is based on theoretical mineral/phase composition or created by the user based from BSE, X-ray spectral windows counts and/or ratios.

TIMA-X has four X-ray analysis scanning modes to identify mineral/compounds: High-Resolution Mapping (THRM), Point Spectrometry (TPS), Line Mapping (TLM) and Dot Mapping (TDM) which can be used further optimized for different analysis types (Figure 1). The THRM collects a BSE signal and an X-Ray spectrum at a set resolution by the user to map the particles and fields (in the case of a polished thin sections or core), it is used to collect modal and textural information like liberation or exposure analysis. For the TPS, individual phases/grains are determined using the BSE only, areas of the similar BSE brightness are identified as homogenous regions and then at the centre of each of these regions an X-ray analysis point is taken. In the line mapping mode (TLM), each field is covered by equidistant horizontal lines using a specified line spacing, which is user dependent. At a set pixel spacing on each line an X-ray analysis point is taken. This is analysis mode is good for modal mineralogy and grain size information. The TDM analysis mode uses a BSE grid at a determined pixel spacing to segment areas of homogenous BSE intensities and identifies the centre of the greatest inscribed circle (similar to the point spectroscopy), it then created a grid for the X-ray acquisition with the specified resolution spacing the same as the BSE. The X-ray data from zones of similar BSE and EDS signals are summed to produce a single higher quality spectra for each final segment, this is used for the mineral identification.  This analysis mode is good for modal mineralogy, grain size and liberation analysis.

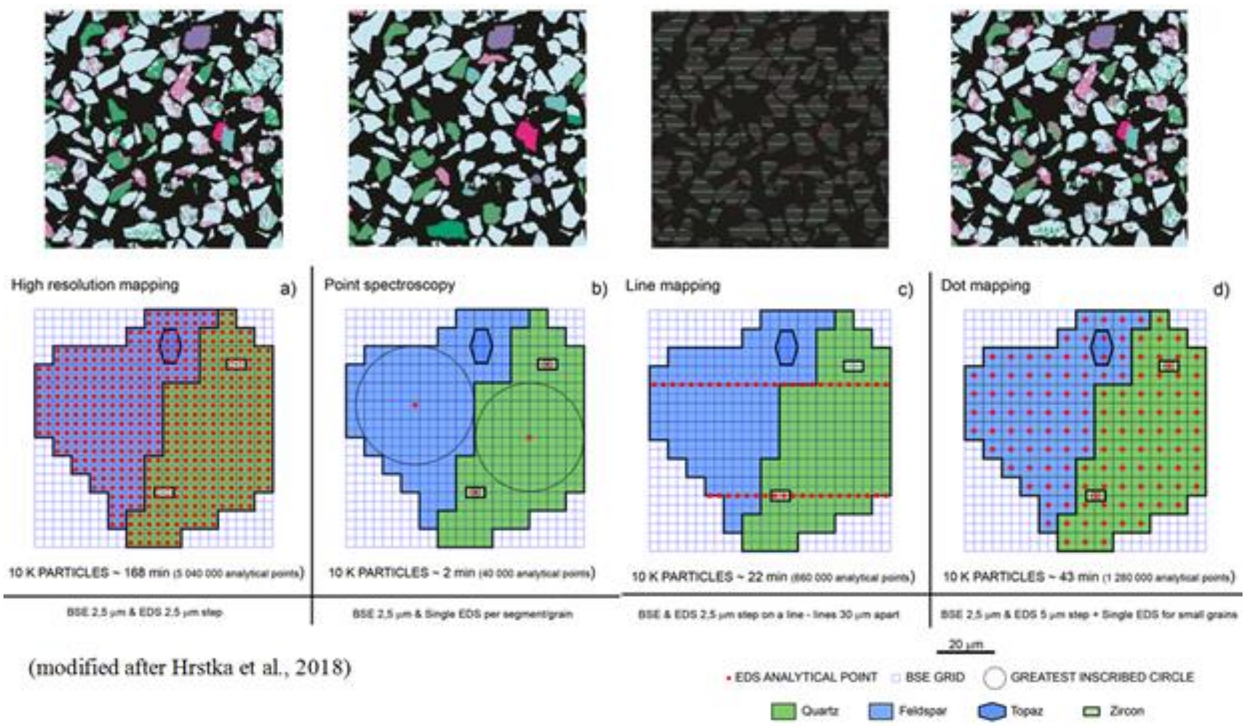



**Figure 1:  TIMA-X Analysis Modes**

### 2.1. TIMA Assay Reconciliation

Key TIMA mineralogical assays have been regressed with chemical assays for the samples to validate the data. The QA/QC results are presented in Table 1 for the whole rock elements. The assay reconciliation is shown graphically in Figure 2. Overall correlation, as measured by R-squared criteria was 0.98, indicating a satisfactory QA/QC reconciliation.

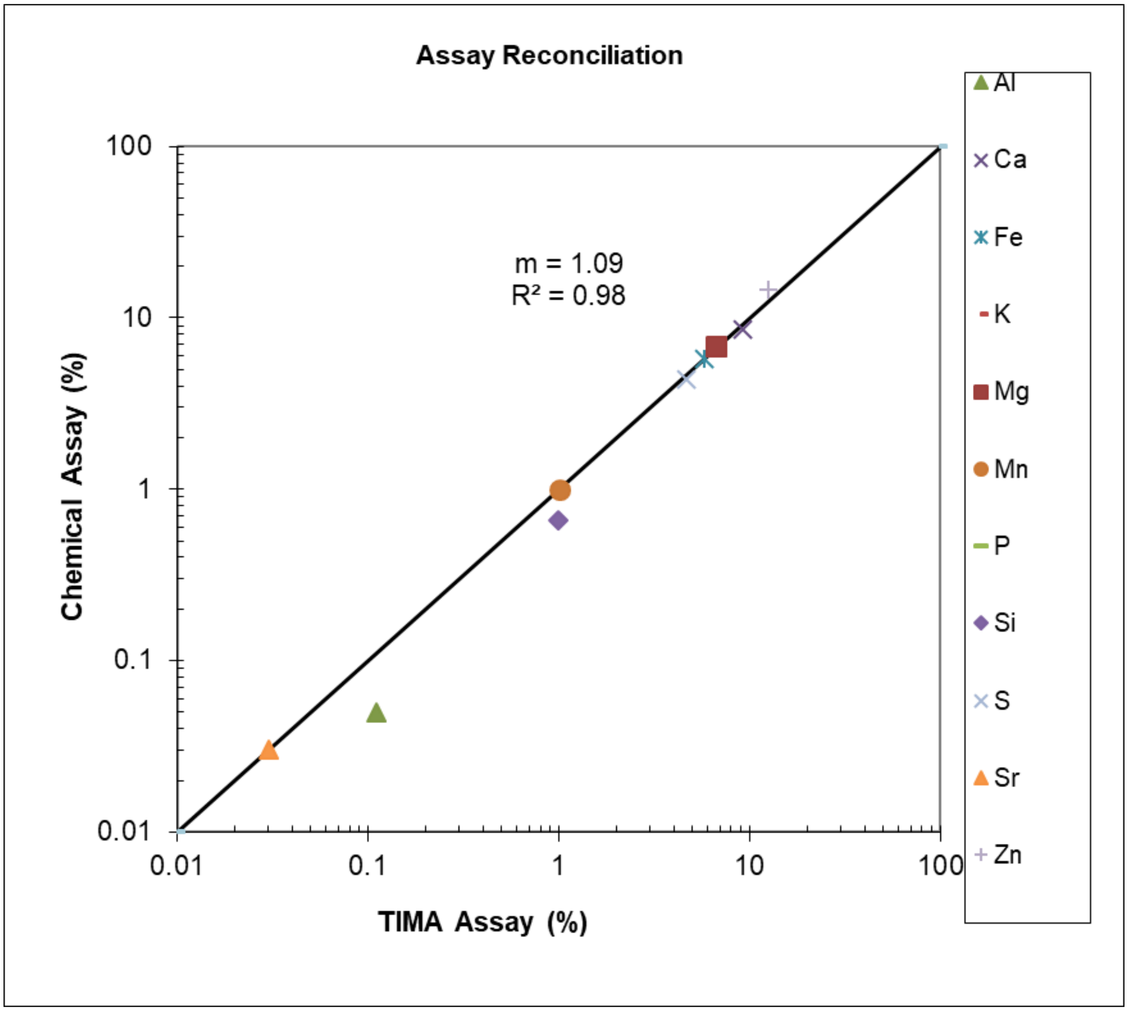



**Figure 2: TIMA Calculated and Direct Chemical Assay Reconciliation for the Sample**

**Table 1: TIMA Assay Reconciliation**

| Element | Aluminum | | Calcium | | Iron | | Potassium | | Magnesium | | Manganese | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Name | Al (Calc) | Al (Assay) | Ca (Calc) | Ca (Assay) | Fe (Calc) | Fe (Assay) | K (Calc) | K (Assay) | Mg (Calc) | Mg (Assay) | Mn (Calc) | Mn (Assay) |
| Sludge Sample | 0.11 | 0.05 | 9.22 | 8.53 | 5.79 | 5.79 | 0.00 | 0.00 | 6.61 | 6.87 | 1.98 | 1.83 |
| Element | Phosphorus | | Silicon | | Sulphur | | Strontium | | Zinc | | | |
| Sample Name | P (Calc) | P (Assay) | Si (Calc) | Si (Assay) | S (Calc) | S (Assay) | Sr (Calc) | Sr (Assay) | Zn (Calc) | Zn (Assay) | | |
| Sludge Sample | 0.00 | 0.01 | 0.99 | 0.66 | 4.68 | 4.41 | 0.03 | 0.03 | 12.5 | 14.6 | | |

### 2.2. Modal Mineralogy

The bulk modal mineralogy by TIMA analysis is summarized in Table 2 and represented in Figure 3.

The Faro Sludge sample contained multiple sulphates of Zn, Fe, Mg, Mn, S, (Ca, Si)-O Phase at 28.2% and Ca, S, (Mn)-O Phase at 18.4%. Gypsum was at 17.6% with minor to trace amounts of calcite (9.55%), Mn,Zn-Oxide (Fe) (3.63%), carbonates (3.57%), Zn-Oxide (1.92%), silicates (1.32%), complex sulphur (0.14%), and sulphides (0.04%).

Quantitative SEM-EDS analysis and TIMA images of sulphur mineral elemental compositions are presented in Appendix A to B.

**Table 2: Bulk Modal Mineralogy by TIMA**

| Mineral Mass | Sludge Sample |
|---|---|
| Sulphides | 0.04 |
| Silicates | 1.32 |
| Zn-Oxide | 1.92 |
| Mn, Zn, (Fe) Oxide | 3.63 |
| Oxides | 0.46 |
| Calcite | 9.55 |
| Carbonates | 3.57 |
| Gypsum | 17.6 |
| Jarosite | 0.00 |
| Barite | 0.00 |
| Complex Sulfur | 0.14 |
| Zn, Fe, Mg, Mn, S, (Ca, Si) - O Phase | 28.2 |
| Ca, S, (Mn) - O Phase | 18.4 |
| Mg, Al, S, (Zn, Si) - O Phase | 1.08 |
| Fe, Zn, Mg, (S, Si) - O Phase | 12.9 |
| Mg, Fe, Ca, Zn, (S) - O Phase | 1.20 |
| Other | 0.10 |
| **Total** | **100.0** |

**Figure 3: Bulk Modal Mineralogy by TIMA**

Sulphur occurs predominantly in gypsum and Mg, Al, S, (Zn, Si)-O Phase with elemental abundances of 44.8% and 25.0%, respectively. Minor elemental abundances of sulphur in other phases ranging from 0.21% to 14.3%, with contaminates of Al and Si. There were 3 grains of pyrite within the sulphide grouping at 0.41% (Figure 4).

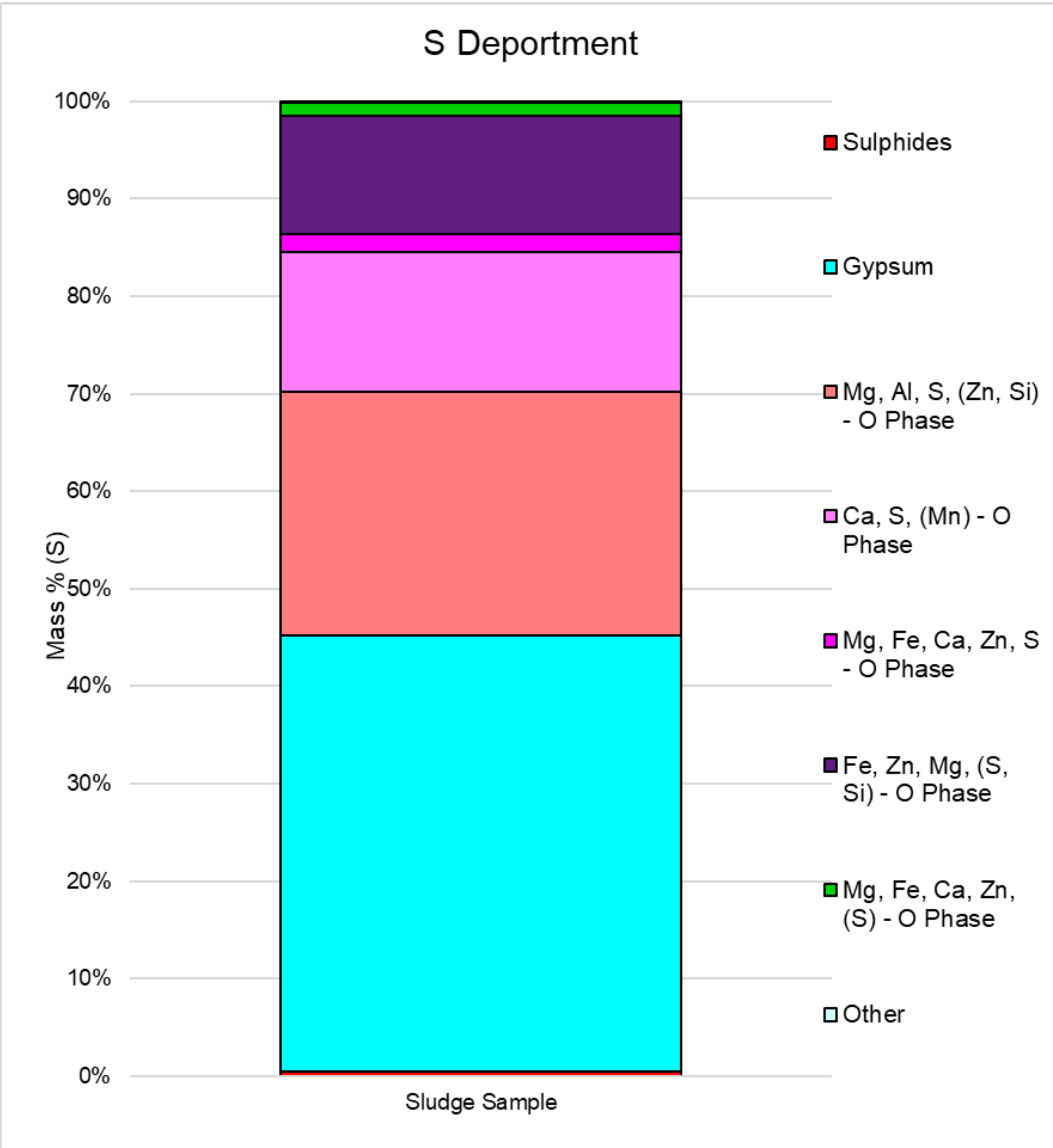



**Figure 4: S Deportment by TIMA**

Zinc occurs predominantly in Zn, Fe, Mg, Mn, S, (Ca, Si)-O Phase and Ca, S, (Mn)-O Phase with elemental abundances of 35.1% and 23.4%, respectively. Remaining elemental abundances are within Zn-Oxide, Mn,Zn (Fe) -Oxide and Fe, Zn, Mg, (S, Si)-O Phase at 10.6%, 11.1% and 15.7%, respectively. Trace amounts in other phases determined by EDS analysis. (Figure 5).

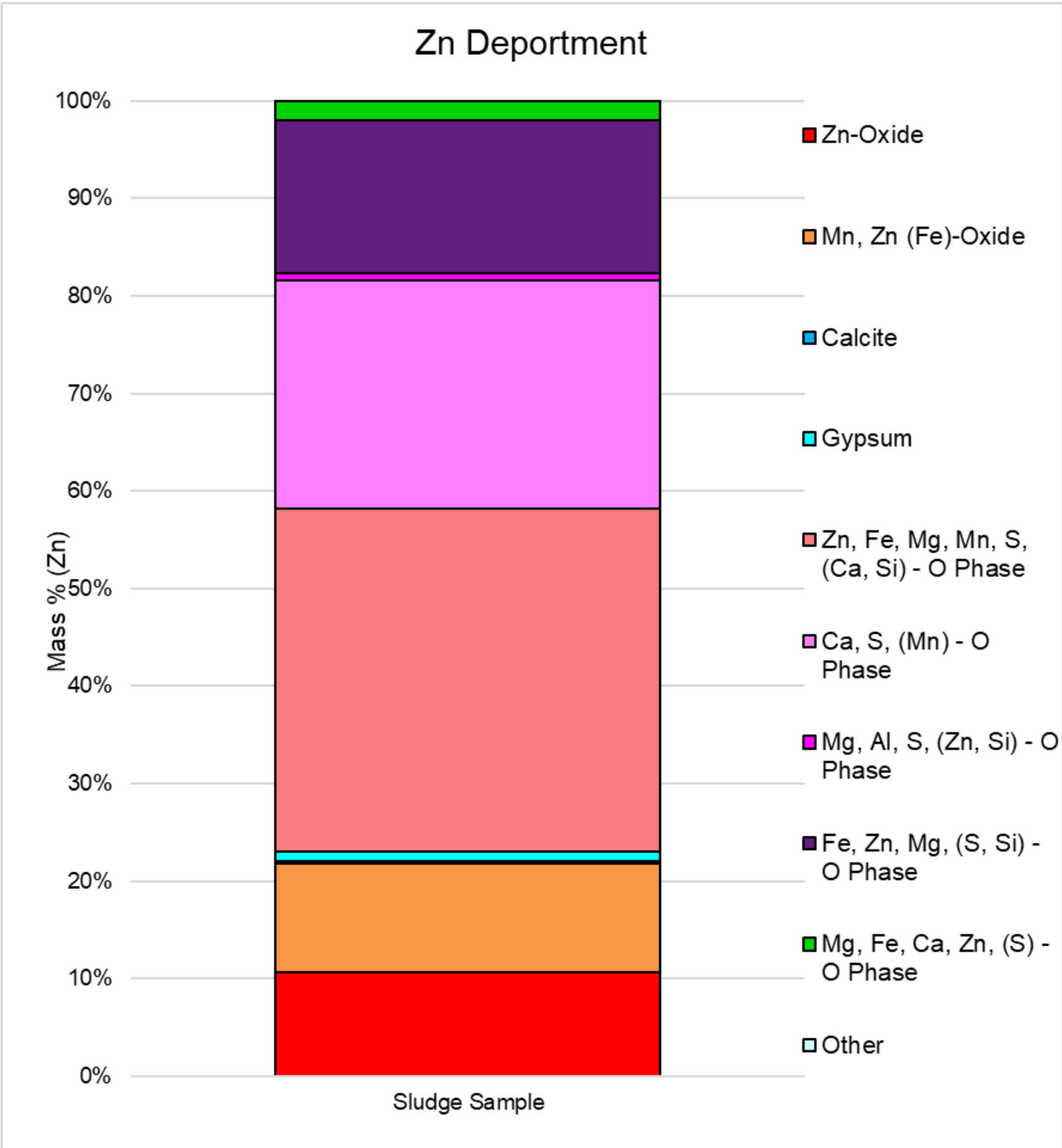



**Figure 5: Zn Deportment by TIMA**

### 3. Additional Notes

- Majority of the sample was Mg, Al, S, (Zn, Si)-O Phase and Zn, Fe, Mg, Mn, S, (Ca, Si)-O Phase
    - Almost all phases had a range of S, with contaminates of Al and Si.
- Gypsum was the 2nd most abundant mineral.
- Main carbonates were mostly dolomite and ankerite.
- Trace amounts of pyrite were observed within the sulphide grouping.

## *Appendix A – Quantitative SEM-EDS Analysis*

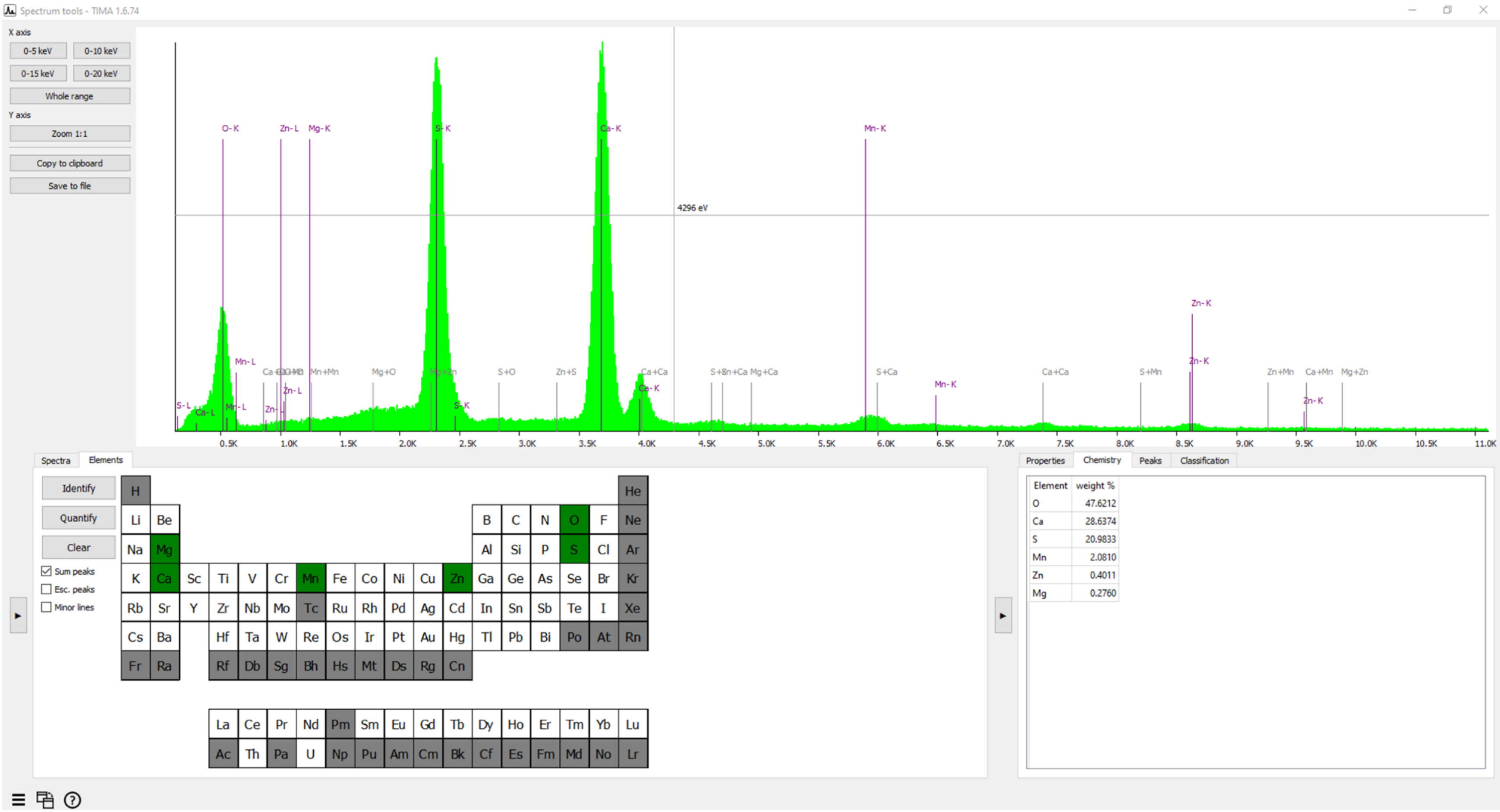



**Figure 1: SEM-EDS of Ca, S, (Mn)-O Phase**

SGS

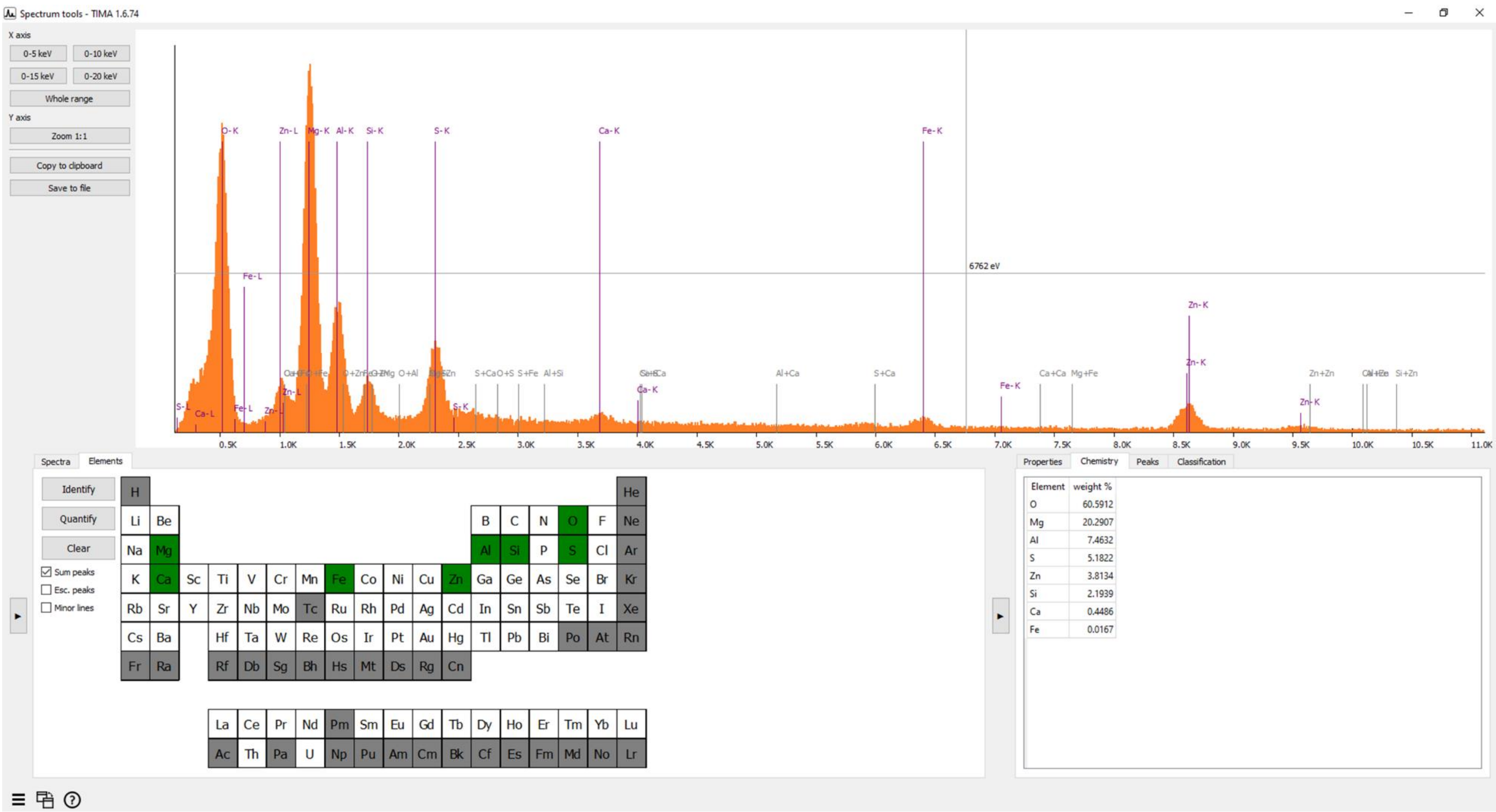



**Figure 2: SEM-EDS of Mg, Al, S, (Zn, Si)-O Phase**

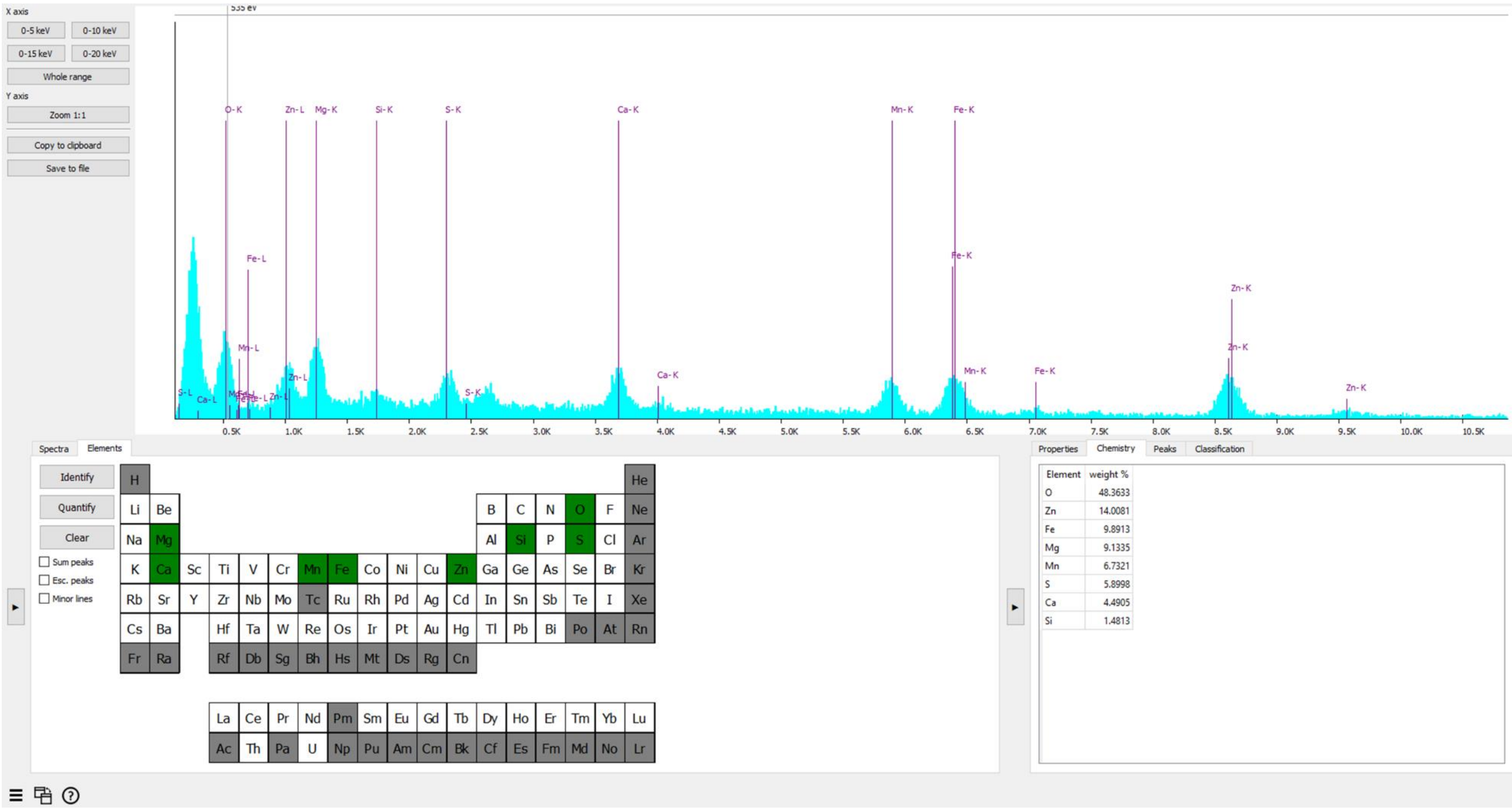



**Figure 3: SEM-EDS of Zn, Fe, Mg, Mn, S, (Ca, Si)-O Phase**

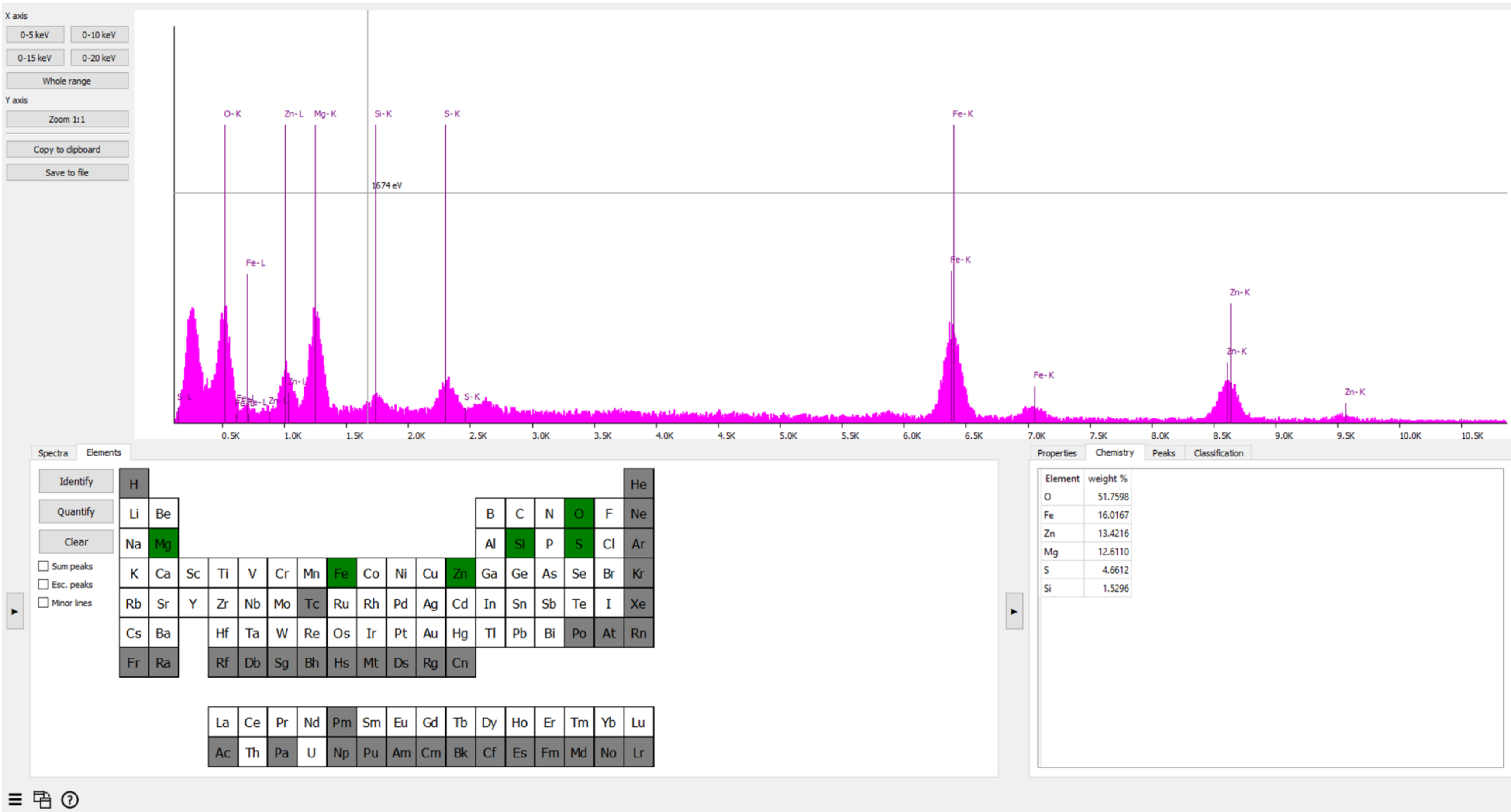



**Figure 4: SEM-EDS of Fe, Zn, Mg, (S, Si)-O Phase**

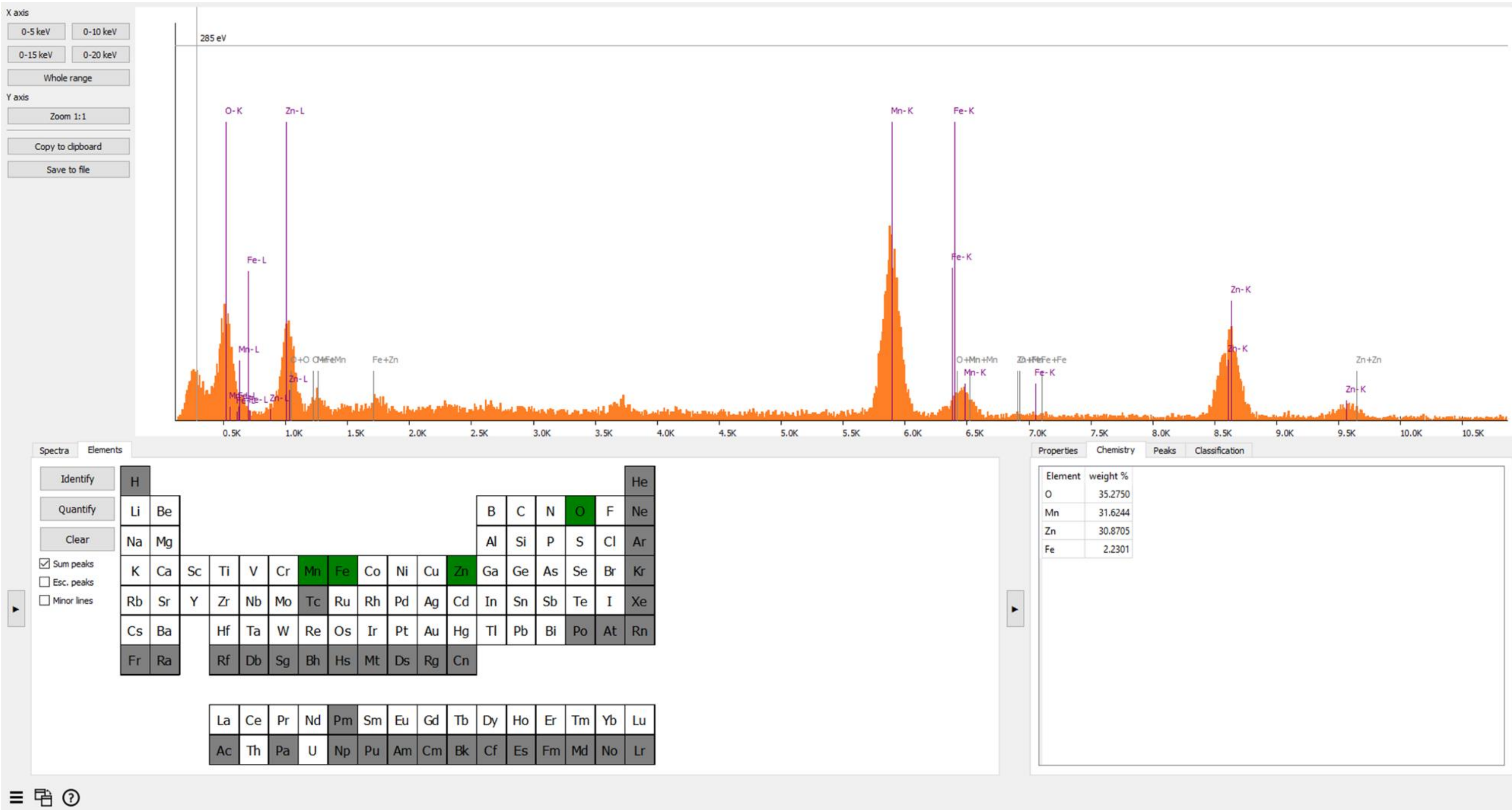



**Figure 5: SEM-EDS of Mn, Zn, (Fe) - Oxide**

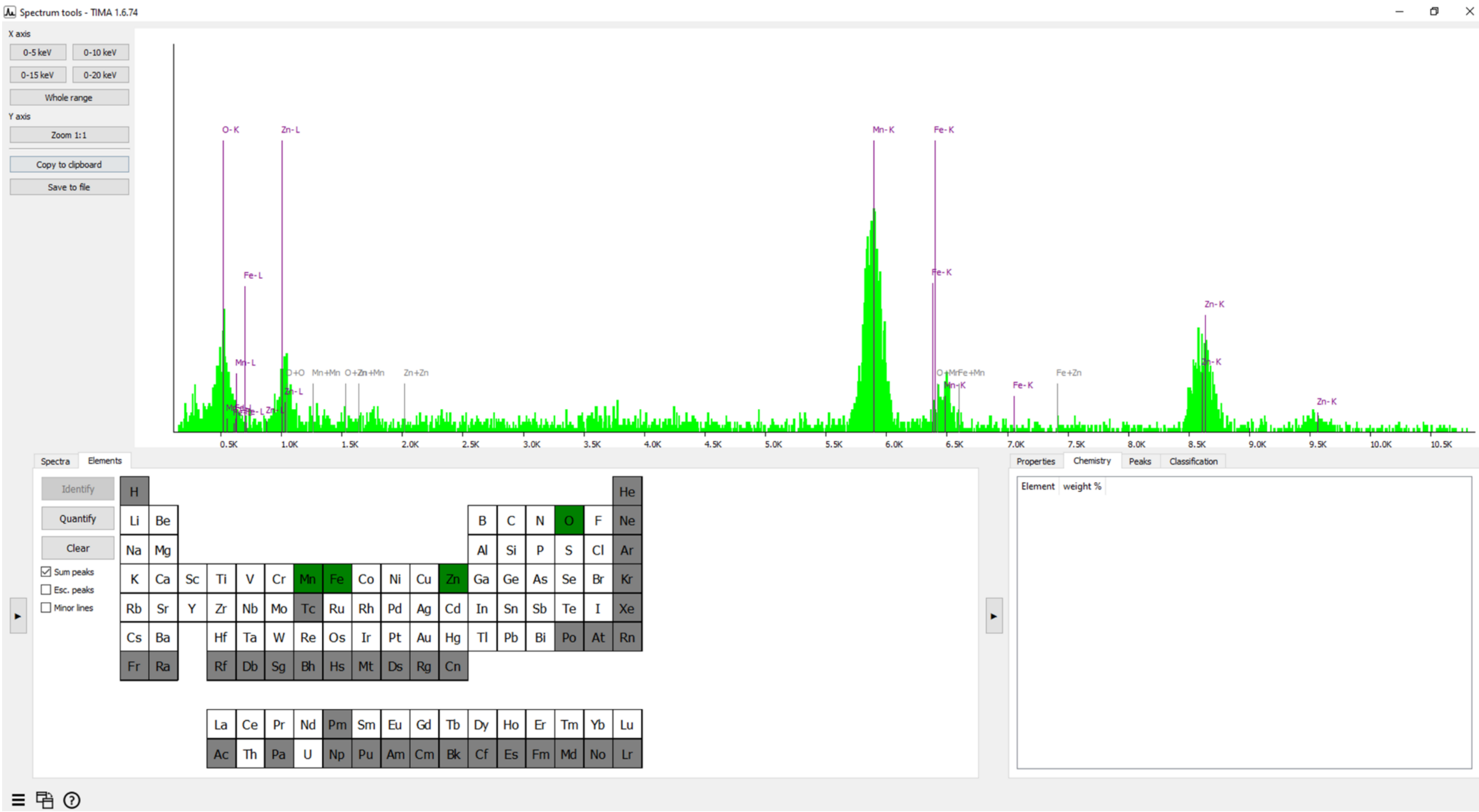



**Figure 6: SEM-EDS of Mn, Zn, (Fe) - Oxide**

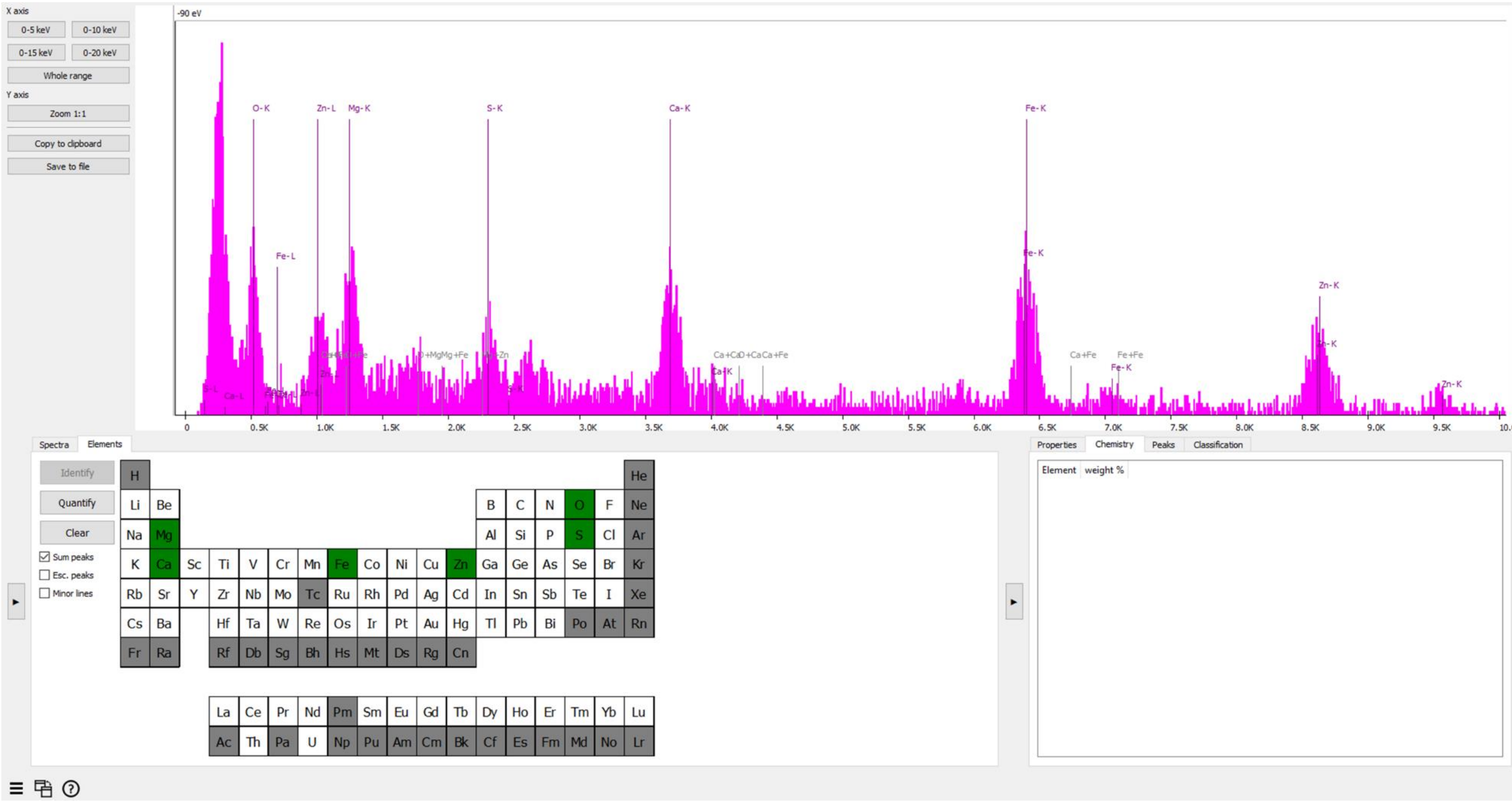


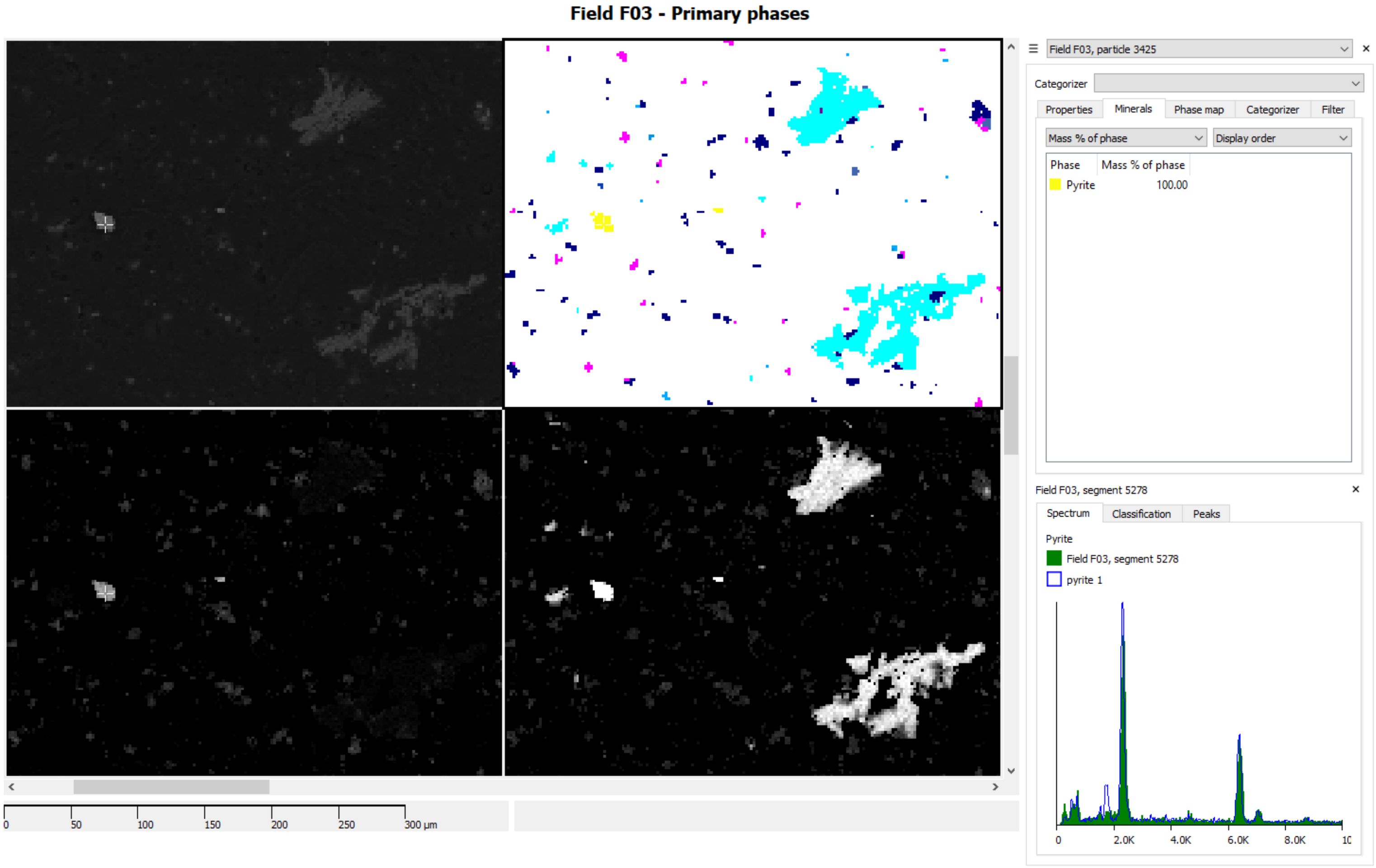

**Figure 7: SEM-EDS of Mg, Fe, Ca, Zn, S-O Phase**

SGS

***Appendix B – TIMA Images***

SGS

Pyrite

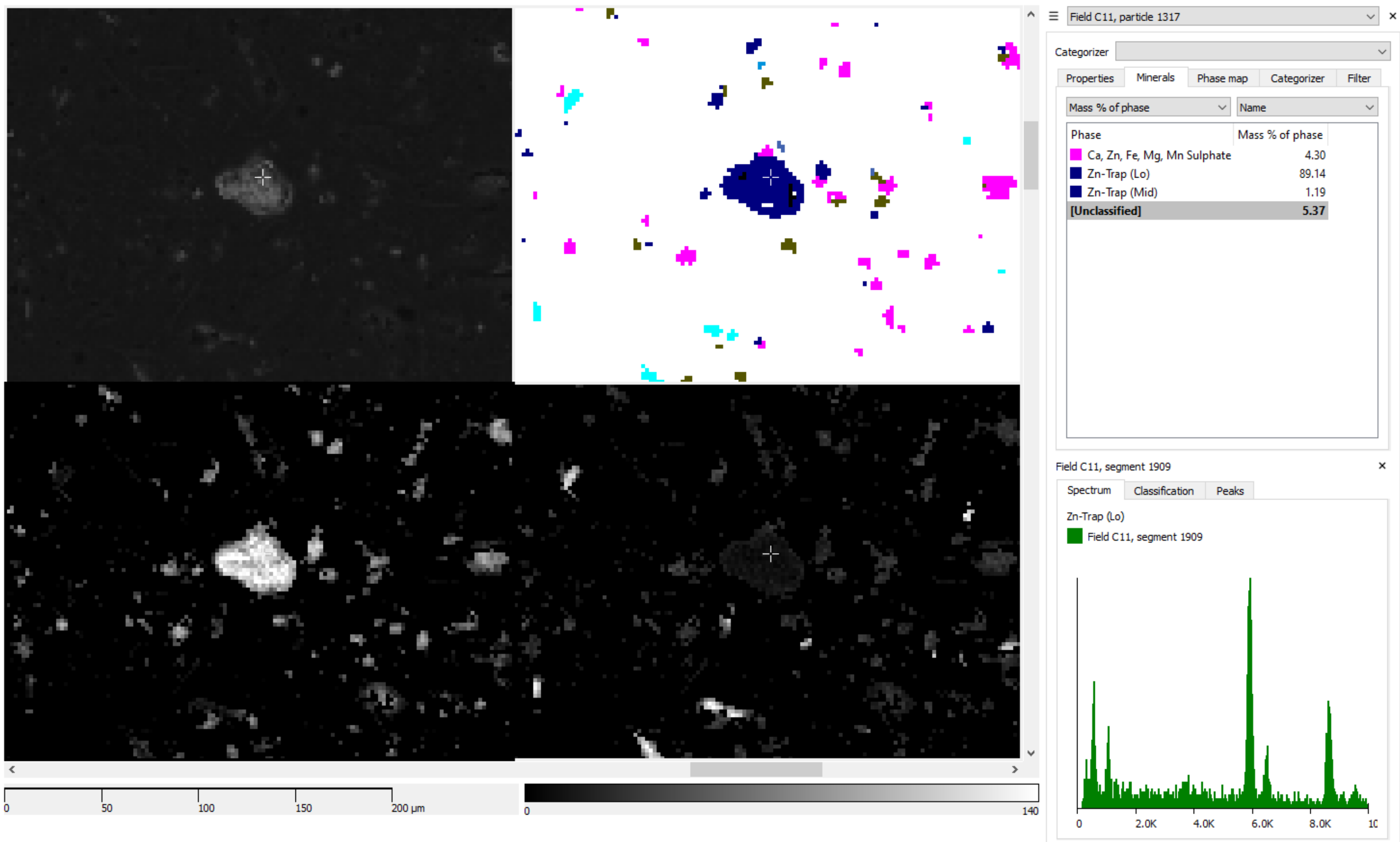



Top Left: BSE Image
Top Right: TIMA Phases
Bottom Left: Relative Intensity of Fe
Bottom Right: Relative Intensity of S.

**Figure 1: TIMA Image of Pyrite**

Zn-Oxide

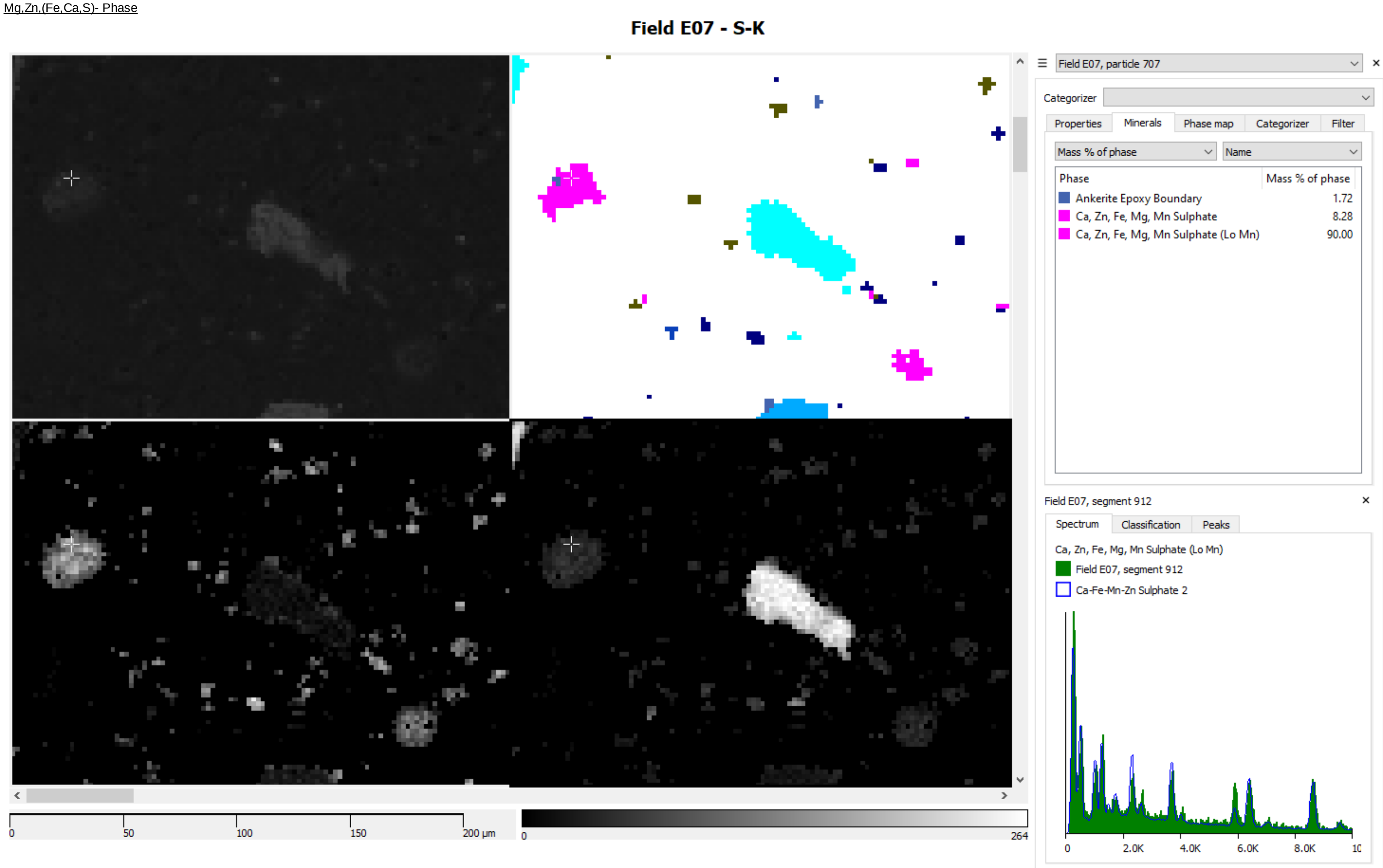
**Field C11 - Zn-K**




Top Left: BSE Image
Top Right: TIMA Phases
Bottom Left: Relative Intensity of Mg
Bottom Right: Relative Intensity of S.

**Figure 2: TIMA Image of Mn, Zn, (Fe) - Oxide**

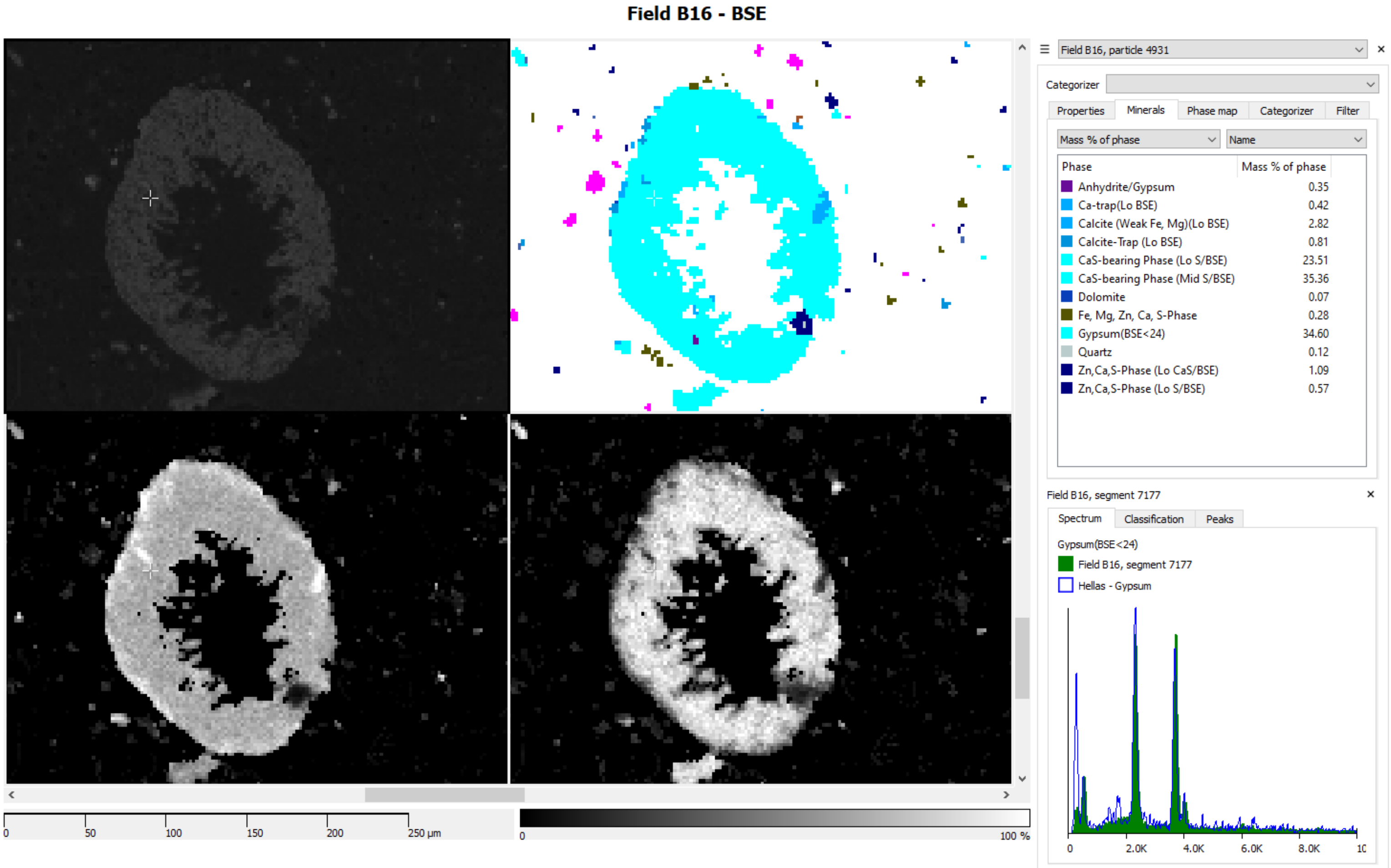
Mg,Zn,(Fe,Ca,S)- Phase




Top Left: BSE Image
Top Right: TIMA Phases
Bottom Left: Relative Intensity of Zn
Bottom Right: Relative Intensity of S.

**Figure 3: TIMA Image of Mg,Zn,(Fe,Ca,S)- Phase**

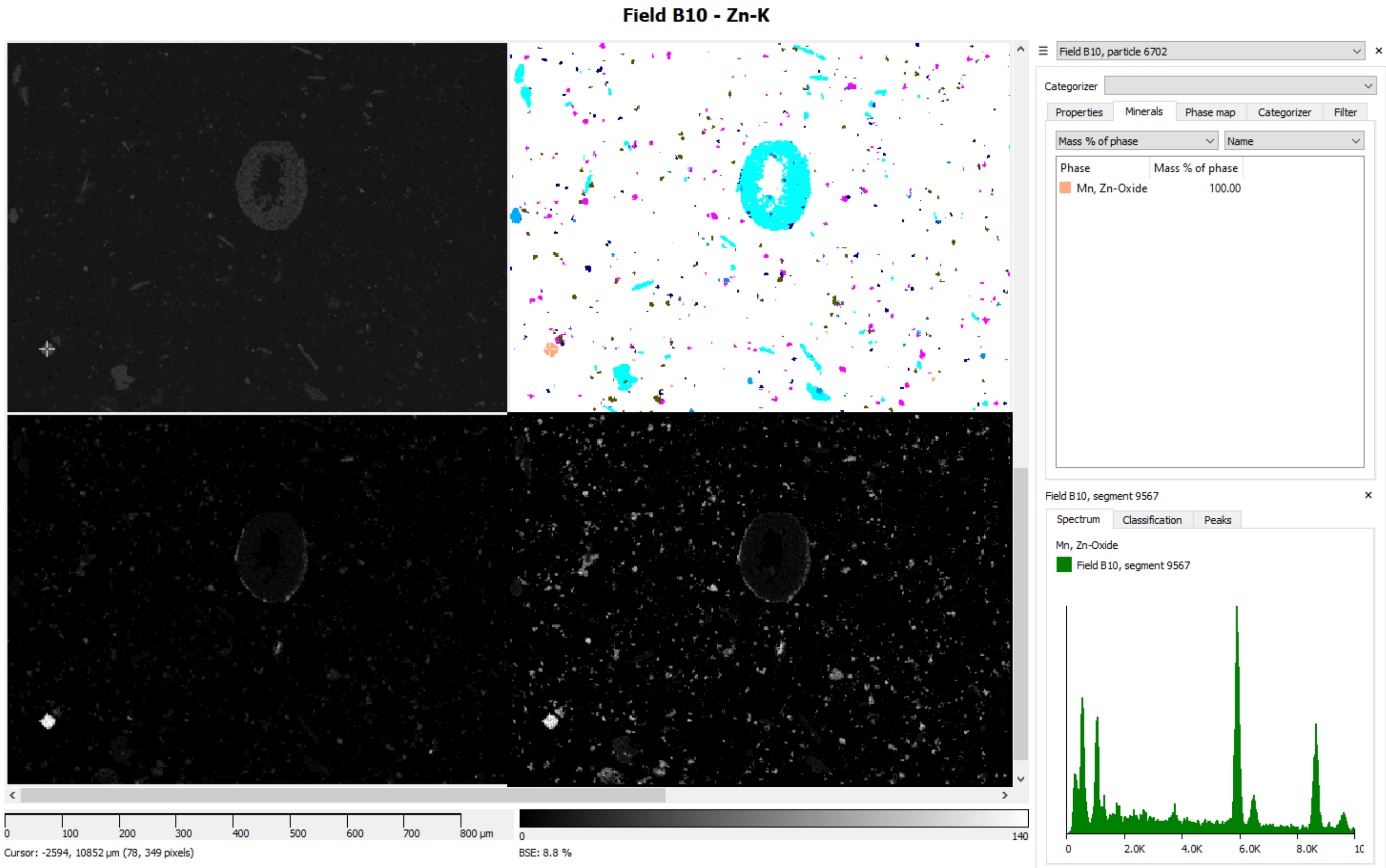
Gypsum




Top Left: BSE Image
Top Right: TIMA Phases
Bottom Left: Relative Intensity of Ca
Bottom Right: Relative Intensity of S.

**Figure 4: TIMA Image of Gypsum**

Mn, Zn-Oxide




Top Left: BSE Image
Top Right: TIMA Phases
Bottom Left: Relative Intensity of Mn
Bottom Right: Relative Intensity of Zn.

**Figure 5: TIMA Image of Mn, Zn, (Fe) - Oxide**

## Appendix B: QA/QC Results

## Faro WTP Sludge QA/QC Results

| QC Test | SRK QC Criteria | Results |
|---|---|---|
| **paste pH** | | |
| Standard Reference Material (n=1) | Within specified tolerance ranges. | All passed. |
| **Total C and TIC** | | |
| Carbon balance (Total C > TIC) (n=0) | For samples > 10X the detection limit (DL), Total Carbon should be greater than Total Inorganic Carbon, if not the % difference should be within +/-20% | No TIC reported |
| Crush Duplicate (n=1) for Total C | For samples > 10X the detection limit (DL), % RPD within +/-30% | All passed. |
| Standard Reference Material (n=1) for Total C | Within specified tolerance ranges. | All passed. |
| **Total S & Total Sulphate** | | |
| Sulphur balance (total S > sulphate S) (n=1) | For samples > 10X the detection limit (DL), Total Sulphur should be greater than Total Sulphate, if not the % difference should be within +/-20% | All passed. |
| Crush Duplicate (n=1) for Total S | For samples > 10X the detection limit (DL), % RPD within +/-30% | All passed. |
| Standard Reference Material (n=1) for SO4 | Within specified tolerance ranges. | All passed. |
| **Total S-Leco and S-ICP** | | |
| Comparison between Total S-Leco and S-ICP (n=2) | For samples >10X detection limit (DL), % RPD within +/-20% | All passed. |
| **Trace Elements (Aqua Regia Digestion with ICP Finish)** | | |
| Method Blank (n=1) | <2X Detection Limit | All passed. |
| Crush Duplicate (n=1) | For samples >10X detection limit (DL), % RPD within +/- 30%, For ICP metal scan, it is acceptable for 10% of parameters to be outside of this criterion. | All passed. |
| Standard Reference Material (n=1) | Within +/-15 % Difference or within the tolerance ranges | All passed. |
| **WRA-ICP** | | |
| Method Blank (n=1) | <2X Detection Limit | All passed. |
| Crush Duplicate (n=1) | For samples >10X detection limit (DL), % RPD within +/- 30%, For ICP metal scan, it is acceptable for 10% of parameters to be outside of this criterion. | All passed. |
| Standard Reference Material (n=1) | Within +/-15 % Difference or within the tolerance ranges | SrO - outside 15% and the tolerance ranges but there's no need to recheck. |
| **Raw Water** | | |
| Ion Balance (n=4) | EC>100uS/cm, % difference should be within +/-10% | All passed. |
| Leachate Duplicate (n=1) | For samples >10X detection limit (DL), % RPD within +/- 20%, For ICP metal scan, it is acceptable for 10% of parameters to be outside of this criterion. | All passed. |
| SO4-S vs S-ICP (n=4) | For samples > 10X the detection limit (DL), the % difference should be within +/-20% | Faro Pit - S-ICP >10x DL but SO4-S <10x DL |
| Standard Reference Material (n=1) | Within specified tolerance ranges. | All passed. |

| | | |
|---|---|---|
| **Custom SFE** | | |
| Method Blank (n=1) | <2X Detection Limit | All passed. |
| Ion Balance (n=4) | EC>100uS/cm, % difference should be within +/-10% | All passed. |
| Leachate Duplicate (n=1) | For samples >10X detection limit (DL), % RPD within +/- 20%, For ICP metal scan, it is acceptable for 10% of parameters to be outside of this criterion. | All passed. |
| SO4-S vs S-ICP (n=4) | For samples > 10X the detection limit (DL), the % difference should be within +/-20% | All passed. |
| Standard Reference Material (n=1) | Within specified tolerance ranges. | All passed. |
| **Oxic_DI_pH4** | | |
| Method Blank (n=1) | <5X Detection Limit | EC, ORP and Dissolved Oxygen >5X DL. There is no detection limit for DO, pH, and ORP so these shouldn't be evaluated using the <5x DL QAQC criteria. |
| Ion Balance (n=6) | EC>100uS/cm, % difference should be within +/-10% | All passed. |
| SO4-S vs S-ICP (n=6) | For samples > 10X the detection limit (DL), the % difference should be within +/-20% | All passed. |
| **Oxic_DI_pH7** | | |
| Method Blank (n=1) | <5X Detection Limit | EC, ORP and Dissolved Oxygen >5X DL. There is no detection limit for DO, pH, and ORP so these shouldn't be evaluated using the <5x DL QAQC criteria. |
| Ion Balance (n=6) | EC>100uS/cm, % difference should be within +/-10% | All passed. |
| SO4-S vs S-ICP (n=6) | For samples > 10X the detection limit (DL), the % difference should be within +/-20% | All passed. |
| **Oxic_Vangorda** | | |
| Method Blank (n=1) | <5X Detection Limit | EC, ORP and Dissolved Oxygen >5X DL. There is no detection limit for DO, pH, and ORP so these shouldn't be evaluated using the <5x DL QAQC criteria. |
| Ion Balance (n=6) | EC>100uS/cm, % difference should be within +/-10% | All passed. |
| SO4-S vs S-ICP (n=6) | For samples > 10X the detection limit (DL), the % difference should be within +/-20% | All passed. |
| **Oxic_Faro** | | |
| Method Blank (n=1) | <5X Detection Limit | EC and ORP >5X DL. There is no detection limit for DO, pH, and ORP so these shouldn't be evaluated using the <5x DL QAQC criteria. |
| Ion Balance (n=6) | EC>100uS/cm, % difference should be within +/-10% | All passed. |
| SO4-S vs S-ICP (n=6) | For samples > 10X the detection limit (DL), the % difference should be within +/-20% | All passed. |

| | | |
|---|---|---|
| **Anoxic_DI_pH4** | | |
| Method Blank (n=2) | <5X Detection Limit | EC and ORP >5X DL. There is no detection limit for DO, pH, and ORP so these shouldn't be evaluated using the <5x DL QAQC criteria. |
| Ion Balance (n=5) | EC>100uS/cm, % difference should be within +/-10% | All passed. |
| SO4-S vs S-ICP (n=5) | For samples > 10X the detection limit (DL), the % difference should be within +/-20% | All passed. |
| **Anoxic_DI_pH7** | | |
| Method Blank (n=2) | <5X Detection Limit | EC and ORP >5X DL. There is no detection limit for DO, pH, and ORP so these shouldn't be evaluated using the <5x DL QAQC criteria. |
| Ion Balance (n=5) | EC>100uS/cm, % difference should be within +/-10% | All passed. |
| SO4-S vs S-ICP (n=5) | For samples > 10X the detection limit (DL), the % difference should be within +/-20% | All passed. |
| **Anoxic_Vangorda** | | |
| Method Blank (n=2) | <5X Detection Limit | EC and ORP >5X DL; The following parameters failed the <5X DL: Acidity (to pH 8.3), Alkalinity (to pH 4.5), Ammonia (as N), and various Dissolved Metals. There is no detection limit for DO, pH, and ORP so these shouldn't be evaluated using the <5x DL QAQC criteria. |
| Ion Balance (n=5) | EC>100uS/cm, % difference should be within +/-10% | All passed. |
| SO4-S vs S-ICP (n=5) | For samples > 10X the detection limit (DL), the % difference should be within +/-20% | All passed. |
| **Anoxic_Faro** | | |
| Method Blank (n=2) | <5X Detection Limit | EC and ORP >5X DL; The following parameters failed the <5X DL: Acidity (to pH 8.3), Alkalinity (to pH 4.5), Ammonia (as N), Dissolved Sulphate, and various Dissolved Metals. There is no detection limit for DO, pH, and ORP so these shouldn't be evaluated using the <5x DL QAQC criteria. |
| Ion Balance (n=5) | EC>100uS/cm, % difference should be within +/-10% | All passed. |
| SO4-S vs S-ICP (n=5) | For samples > 10X the detection limit (DL), the % difference should be within +/-20% | All passed. |

| Sequential Extraction | | |
|---|---|---|
| Method Blank (n=3) | <5X Detection Limit | Several parameters exceeded 5x the DL in the reagents. These results were incorporated in interpretation of the results. |
| Ion Balance (n=8) | EC>100uS/cm, % difference should be within +/-10% | All passed except the leachates from the third extraction step for which fluoride could not be quantified due to interference. A recheck confirmed the anion and nutrient values and the results were accepted as is. |

# Appendix C: Solids Content, Pit Water and Filtrate Analysis, Elemental Content, Titration, Leach Test, Aging Test, and Selective Extraction Data

## CERTIFICATE OF ANALYSIS ▪ ABA RESULTS

**Global ARD Testing Services Inc.**

**GLOBAL PROJECT NO:** 2011
**CLIENT:** SRK Consulting Inc.
**CLIENT PROJECT NAME / NO:** Faro Sludge Aging Test
**REPORT VERSION:** 6

| S. No. | Sample ID | Paste pH | Fizz Rating | Total Carbon | Total Inorganic C | $CaCO_3$ Equivalents*1 | Total Sulphur | HCl Leach Sulphate Sulphur | Na2CO3 Leach Sulphate Sulphur | AP*3 | Mod. ABA NP | NNP*4 | NPR*5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***Units:*** | ***pH Units*** | | **wt %** | **wt %** | **kg CaCO3/tonne** | **wt %** | **wt %** | **wt %** | | ***kg CaCO3/tonne*** | | |
| | ***Reported Detection Limit:*** | ***0.01*** | | ***0.01*** | ***0.02*** | ***1.7*** | ***0.01*** | ***0.01*** | ***0.01*** | ***0.3*** | ***0.5*** | | |
| | | | | | | | | | | | | | |
| 1 | Sludge Homogenized | | | 1.88 | | | 5.42 | 3.94 | 4.70 | | | | |
| 1 R | Sludge Homogenized | | | 1.88 | | | 5.46 | | | | | | |
| | **QUALITY ASSURANCE / QUALITY CONTROL** | | | | | | | | | | | | |
| ***Replicate Analysis:*** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| ***Certified Reference Material (CRM) Analysis:*** | | | | | | | | | | | | | |
| Certified Reference Material | | KZK-1 | | GS310-7 | | | | RTS-3a | | | | | |
| **CRM True Value** | | **8.80** | | **4.16** | | | | **1.10** | | | | | |
| Reference Material Results | | 8.84 | | 4.11 | | | | 1.07 | | | | | |
| ***Tolerance (+/-) or Acceptance Range*** | | ***0.09*** | | ***90 - 110%*** | | | | ***0.99 - 1.21*** | | | | | |
| ***Method Blank Analysis:*** | | | | | | | | | | | | | |
| Method Blank Results | | | | <0.01 | | | | <0.01 | | | | | |
| ***GLOBAL SOP No. / Method:*** | | *ARD-004* | *ARD-005* | *HCl leach/ Coulometer* | *HCl leach/ Coulometer* | *Calc.* | *LECO* | *ARD-013* | *(HCl leach)* | *Calc.* | *ARD-005* | *Calc.* | *Calc.* |

***NOTES:***
Job No: YVR2010304
Acceptance criteria at Global ARD Testing for all CRMs is ±10 % of certified value.
**Date of Analysis:** Apr. 22, 2020
pH of DI water used: 5.67
EC of DI water used: 0.45
***METHODS:***
Total sulphur, Total Carbon by Leco.
***ABBREVIATIONS:***
R = Rep = Replicate (a replicate is a sub-sample scooped from a single pulp sample bag produced per client sample)
D = Dup = Duplicate (a duplicate is 2nd sub-pulp sample bag produced by processing a split of the original client sample received. A duplicate pulp sample is prepared only at client request)
NP = Neutralization Potential
Calc. = Calculation
IND = Indeterminate
***CALCULATIONS:***
- *1 CaCO3 Equivalents: based on TIC
- *2 Non-Extractable Sulphur: Total sulphur - (sulphate sulphur + sulphide sulphur)
- *3 AP (Acid Potential): Sulphide-Sulphur x 31.25
- *4 NNP (Net Neutralization Potential): NP - AP
- *5 NPR (Neutralization Potential Ratio): NP/AP

***REFERENCES:***
**Sample Preparation:** ASTM E877-08; MEND Report 1.20.1, Version 0 (2009)
**Sulphate Sulphur (HCl Leach):** Based on MEND Method. The S extracted is determined by analysing the extract for SO4 using UV-Vis Spectrophotometer (STD Method 4500-SO42- E).
**Sulphate Sulphur (Sodium Carbonate Leach):** Modified ASTM D2492-02 Method. The S extracted is determined by analysing the extract for SO4 using UV-Vis Spectrophotometer (STD Method 4500-SO42- E).

## CERTIFICATE OF ANALYSIS ▪ AS-RECEIVED SAMPLE

**Global**
**ARD Testing Services Inc.**

**GLOBAL PROJECT NO:** 2011
**CLIENT:** SRK Consulting Inc.
**GLOBAL PROJECT NO:** 2011
**CLIENT:** SRK Consulting Inc.
**CLIENT PROJECT NAME / NO:** Faro Sludge Aging Test
**REPORT VERSION:** 6

| Parameter | Method | Unit | RDL | 1 | 1 D | 2 | 3 |
|---|---|---|---|---|---|---|---|
| | | | | Sample ID | | | |
| | | | | Sludge Filtrate | Sludge Filtrate (Dup) | Vangorda Pit | Faro Pit |
| pH | Meter | pH units | 0.01 | 8.4 | 8.5 | 3.6 | 6.93 |
| EC | Meter | µS/cm | 1 | 3010 | 3040 | 2730 | 1867.0 |
| ORP | Meter | mV | 1 | 124 | 124 | 281 | 122.0 |
| Dissolved Oxygen | Meter | mg/L | 1 | 8.4 | 8.7 | 8.5 | 9.2 |
| Acidity (to pH 8.3) | Titration | mg $CaCO_3$/L | 0.5 | <0.5 | <0.5 | 560.5 | 66.0 |
| Alkalinity (to pH 4.5) | Titration | mg $CaCO_3$/L | 0.5 | 9.5 | 9.0 | <0.5 | 48.0 |
| Dissolved Sulphate (SO4) | Colourimetry | mg/L | 50 | 2180 | 2180 | 1900 | 1200 |
| Chloride | IC | mg/L | 0.5 | 2.80 | 2.80 | 0.6 | 1.3 |
| Fluoride | SIE | mg/L | 0.2 | 0.80 | 0.80 | 0.48 | 0.48 |
| Nitrate (as N) | IC | mg/L | 0.05 | 0.180 | 0.150 | 0.100 | 0.189 |
| Nitrite (as N) | IC | mg/L | 0.05 | 0.490 | 0.470 | 0.028 | <0.005 |
| Ammonia (as N) | Colourimetry | mg/L | 0.01 | 1.060 | 1.060 | 0.390 | 1.520 |
| BOD (5 day) | DO Meter | mg/L | 4.0 | 6.0 | 12.0 | 11.0 | <4 |
| COD | Spectrophotometer | mg/L | 10.0 | <10 | 22.0 | 66.0 | <10 |
| Orthophosphate | Colourimetry | mg/L | 0.15 | <0.15 | <0.15 | <0.15 | 0.27 |
| Dissolved Organic Carbon | Combustion | mg/L | 0.5 | 4.4 | 4.2 | 1.1 | 1.5 |
| Total Organic Carbon | Combustion | mg/L | 0.5 | 4.4 | 4.4 | 0.8 | 1.1 |
| Total Suspended Solids | Gravimetry | mg/L | 2 | 4 | 2 | 18 | 6 |
| Turbidity | PC Titrate | mg/L | 0.1 | 0.7 | 0.5 | 86.0 | 20.9 |
| ***Dissolved Metals Analysis by ICP-MS:*** | | | | | | | |
| Dissolved Hardness (CaCO3) | ICP-MS | mg/L | 0.5 | 1910.0 | 1910.0 | 1180.0 | 979 |
| Aluminum Dissolved | ICP-MS | mg/L | 0.001 | <0.001 | <0.001 | 1.6 | 0.015 |
| Antimony Dissolved | ICP-MS | mg/L | 0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Arsenic Dissolved | ICP-MS | mg/L | 0.0002 | 0.0007 | 0.0006 | 0.0014 | 0.0003 |
| Barium Dissolved | ICP-MS | mg/L | 0.0002 | 0.0192 | 0.0202 | 0.0181 | 0.0119 |
| Beryllium Dissolved | ICP-MS | mg/L | 0.0001 | <0.0001 | <0.0001 | 0.0002 | <0.0001 |
| Bismuth Dissolved | ICP-MS | mg/L | 0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Boron Dissolved | ICP-MS | mg/L | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Cadmium Dissolved | ICP-MS | mg/L | 0.00001 | 0.00009 | 0.00009 | 0.0792 | 0.0106 |
| Calcium Dissolved | ICP-MS | mg/L | 0.05 | 481.0 | 483.0 | 228.0 | 209 |
| Chromium Dissolved | ICP-MS | mg/L | 0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Cobalt Dissolved | ICP-MS | mg/L | 0.0001 | 0.0007 | 0.0007 | 0.601 | 0.113 |
| Copper Dissolved | ICP-MS | mg/L | 0.0005 | 0.0007 | 0.0007 | 0.303 | 0.0013 |
| Iron Dissolved | ICP-MS | mg/L | 0.02 | <0.02 | <0.02 | 106 | 0.27 |
| Lead Dissolved | ICP-MS | mg/L | 0.0005 | <0.0005 | <0.0005 | 0.0722 | <0.0005 |
| Lithium Dissolved | ICP-MS | mg/L | 0.0005 | 0.1070 | 0.1080 | 0.0463 | 0.0663 |
| Magnesium Dissolved | ICP-MS | mg/L | 0.05 | 172.0 | 172.0 | 148.0 | 111 |
| Manganese Dissolved | ICP-MS | mg/L | 0.0002 | 0.0013 | 0.001 | 49.4 | 12.1 |
| Mercury Dissolved | ICP-MS | mg/L | 0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Molybdenum Dissolved | ICP-MS | mg/L | 0.0001 | 0.0014 | 0.0006 | 0.0005 | <0.0001 |
| Nickel Dissolved | ICP-MS | mg/L | 0.0005 | 0.0026 | 0.0009 | 0.46 | 0.185 |
| Phosphorus Dissolved | ICP-MS | mg/L | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Potassium Dissolved | ICP-MS | mg/L | 0.05 | 12.3 | 12.5 | 3.01 | 9.74 |
| Selenium Dissolved | ICP-MS | mg/L | 0.0005 | 0.0009 | 0.0009 | 0.0043 | 0.0021 |
| Silicon Dissolved | ICP-MS | mg/L | 0.05 | 0.17 | 0.17 | 4.58 | 3.39 |
| Silver Dissolved | ICP-MS | mg/L | 0.00008 | <0.00008 | <0.00008 | <0.00008 | <0.00008 |
| Sodium Dissolved | ICP-MS | mg/L | 0.02 | 31.1 | 30.7 | 7.63 | 23.5 |
| Strontium Dissolved | ICP-MS | mg/L | 0.0002 | 8.84 | 9.12 | 1.07 | 0.902 |
| Sulphur Dissolved | ICP-MS | mg/L | 0.5 | 631.0 | 629.0 | 545.0 | 317 |
| Tellurium Dissolved | ICP-MS | mg/L | 0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 |
| Thallium Dissolved | ICP-MS | mg/L | 0.00005 | 0.00139 | 0.00145 | 0.00105 | 0.00056 |
| Thorium Dissolved | ICP-MS | mg/L | 0.0001 | <0.0001 | <0.0001 | 0.0001 | <0.0001 |
| Tin Dissolved | ICP-MS | mg/L | 0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Titanium Dissolved | ICP-MS | mg/L | 0.0005 | <0.0005 | <0.0005 | 0.0019 | 0.0008 |
| Tungsten Dissolved | ICP-MS | mg/L | 0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Uranium Dissolved | ICP-MS | mg/L | 0.00005 | <0.00005 | <0.00005 | 0.00623 | 0.00027 |
| Vanadium Dissolved | ICP-MS | mg/L | 0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Zinc Dissolved | ICP-MS | mg/L | 0.001 | 0.028 | 0.025 | 164.000 | 33.3 |
| Zirconium Dissolved | ICP-MS | mg/L | 0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| ***Ion Balance:*** | | | | | | | |
| Major Anions | Calc. | meq/L | | 45.78 | 45.76 | 39.63 | 26.04 |
| Major Cations | Calc. | meq/L | | 40.02 | 40.12 | 34.83 | 22.34 |
| Difference | Calc. | meq/L | | -5.75 | -5.65 | -4.81 | -3.70 |
| Balance (%) | Calc. | % | | -6.7% | -6.6% | -6.5% | -7.6% |
| | | | *Shake Flask Extract ID:* | *1070332* | *1070361* | *1077944* | *1077955* |

***NOTES:***
Job No: 20V591293 / 20V592924
**Date of Analysis (24 h):** April 7/15, 2020
pH of DI water used (pH Units): 5.54
EC of DI water used (µS/cm): 0.62
***ABBREVIATIONS:***
R / Rep = Replicate (which involves the analysis of the same Shake Flask Extract aliquot).
D / Dup = Duplicate (which involves the analysis of a separate SF extract, produced by processing a secopnd split of the original client sample received).
Calc. = Calculation
EC = Electrical Conductivity
IC = Ion Chromatography
N/A = Not Applicable.
mg/L = Milligrams per Litre
***REFERENCE:***
Prediction Manual for Drainage Chemistry from Sulphidic Geologic Material, MEND Report 1.20.1; Version 0 - Dec. 2009. Section 11.5; P 11 (8-9).
**Extraction Method used:** Using gyratory shaker for 24 h (± 2 h; gentle agitation).
**Liquid: Solid ratio used:** 3: 1; L: S; 750 mL DI $H_2O$: 250 g of homogenized as received material.

## CERTIFICATE OF ANALYSIS • METALS RESULTS BY AQUA REGIA DIGEST & ICP-MS ANALYSIS ON SOLIDS

**Global ARD Testing Services Inc.**

**GLOBAL PROJECT NO:** 2011
**CLIENT:** SRK Consulting Inc.
**CLIENT PROJECT NAME / NO:** Faro Sludge Aging Test
**REPORT VERSION:** 6

**GLOBAL PROJECT NO:** 2011
**CLIENT:** SRK Consulting Inc.
**CLIENT PROJECT NAME / NO:** Faro Sludge Aging Te
**REPORT VERSION:** 6

| S. No. | Sample ID | Method: IMS-230 / Analyte / Sample Type | Silver (Ag) | Aluminum (Al) | Arsenic (As) | Barium (Ba) | Beryllium (Be) | Bismuth (Bi) | Calcium (Ca) | Cadmium (Cd) | Cerium (Ce) | Cobalt (Co) | Chromium (Cr) | Cesium (Cs) | Copper (Cu) | Iron (Fe) | Gallium (Ga) | Germanium (Ge) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Unit | ppm | % | ppm | ppm | ppm | ppm | % | ppm | ppm | ppm | ppm | ppm | ppm | % | ppm | ppm |
| | | MDL | 0.01 | 0.01 | 0.2 | 10 | 0.05 | 0.01 | 0.01 | 0.02 | 0.02 | 0.1 | 1 | 0.05 | 0.2 | 0.01 | 0.05 | 0.05 |
| 1 | Sludge Homogenized | Pulp | 0.05 | 0.04 | 2.2 | <10 | 0.15 | <0.01 | 8.80 | 29.23 | 10.49 | 276.2 | 3 | <0.05 | 6.6 | 6.40 | 0.15 | <0.05 |
| 1 R | Sludge Homogenized | Pulp | 0.08 | 0.04 | 2.2 | 10 | 0.13 | <0.01 | 8.65 | 28.83 | 10.30 | 274.0 | 2 | <0.05 | 6.7 | 6.34 | 0.16 | <0.05 |
| ***QA/QC:*** | | | | | | | | | | | | | | | | | | |
| ***Certified Reference Material:*** | | | | | | | | | | | | | | | | | | |
| STD OREAS 601 | | | 48.00 | 6.370 | 312.1 | 2653 | 2.08 | 21.14 | 1.32 | 7.78 | 63.0 | 5.20 | 40.0 | 6.74 | 0.099 | 2.59 | 20.42 | 0.09 |
| **True Value STD OREAS 601** | | | **49.18** | **6.30** | **307.0** | | **2.07** | **20.90** | **1.31** | **7.86** | **63.0** | **5.14** | **42** | **6.72** | **0.101** | **2.48** | **20.40** | |
| % Difference | | | -2.4 | 1.1 | 1.7 | | 0.5 | 1.1 | 0.8 | -1.0 | 0.0 | 1.2 | -4.8 | 0.3 | -2.4 | 4.4 | 0.1 | |
| ***Tolerance (%)*** | | | ***1.75*** | ***0.24*** | ***22.0*** | ***NR*** | ***0.15*** | ***1.4*** | ***0.04*** | ***0.48*** | ***4.0*** | ***0.54*** | ***5.8*** | ***0.52*** | ***0.003*** | ***0.14*** | ***0.50*** | ***NR*** |
| ***Method Blank:*** | | | | | | | | | | | | | | | | | | |
| Method Blank | | | <0.01 | <0.01 | <0.2 | <10 | <0.05 | <0.01 | <0.01 | <0.02 | <0.02 | <0.1 | <1 | <0.05 | <0.2 | <0.01 | <0.05 | <0.05 |

| S. No. | Sample ID | Method: IMS-230 / Analyte / Sample Type | Hafnium (Hf) | Indium (In) | Potassium (K) | Lanthanum (La) | Lithium (Li) | Magnesium (Mg) | Manganese (Mn) | Molybdenum (Mo) | Sodium (Na) | Niobium (Nb) | Nickel (Ni) | Phosphorous (P) | Lead (Pb) | Rubidium (Rb) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Unit | ppm | ppm | % | ppm | ppm | % | ppm | ppm | % | ppm | ppm | ppm | ppm | ppm |
| | | MDL | 0.1 | 0.005 | 0.01 | 0.5 | 0.2 | 0.01 | 5 | 0.05 | 0.01 | 0.1 | 0.2 | 10 | 0.5 | 0.1 |
| 1 | Sludge Homogenized | Pulp | <0.1 | <0.005 | 0.02 | 9.6 | 0.6 | 7.54 | 18432 | 0.10 | 0.01 | <0.1 | 313.0 | 43 | 4.2 | 0.2 |
| 1 R | Sludge Homogenized | Pulp | <0.1 | <0.005 | 0.02 | 9.4 | 0.5 | 7.48 | 18410 | 0.11 | 0.01 | <0.1 | 314.5 | 41 | 5.1 | 0.2 |
| ***QA/QC:*** | | | | | | | | | | | | | | | | |
| ***Certified Reference Material:*** | | | | | | | | | | | | | | | | |
| STD OREAS 601 | | | 4.30 | 1.78 | 2.16 | 30.6 | 19.00 | 0.410 | 0.047 | 3.83 | 1.54 | 12.80 | 22.7 | 0.046 | 329.8 | 95.1 |
| **True Value STD OREAS 601** | | | **4.52** | **1.73** | **2.10** | **30.9** | **20.5** | **0.389** | **0.048** | **3.87** | **1.45** | **12.6** | **24.3** | **0.047** | **329.0** | **97.0** |
| % Difference | | | -4.9 | 2.7 | 2.9 | -1.0 | -7.3 | 5.4 | -2.5 | -1.0 | 6.2 | 1.6 | -6.6 | -1.49 | 0.24 | -2.0 |
| ***Tolerance (%)*** | | | ***0.35*** | ***0.21*** | ***0.07*** | ***2.60*** | ***1.6*** | ***0.02*** | ***0.002*** | ***0.44*** | ***0.07*** | ***1.1*** | ***1.3*** | ***0.002*** | ***18.0*** | ***4.0*** |
| ***Method Blank:*** | | | | | | | | | | | | | | | | |
| Method Blank | | | <0.1 | <0.005 | <0.01 | <0.5 | <0.2 | <0.01 | <5 | <0.05 | <0.01 | <0.1 | <0.2 | <10 | <0.5 | <0.1 |

| S. No. | Sample ID | Method: IMS-230 / Analyte / Sample Type | Rhenium (Re) | Sulphur (S) | Antimony (Sb) | Scandium (Sc) | Selenium (Se) | Tin (Sn) | Stronium (Sr) | Tantalum (Ta) | Tellurium (Te) | Thorium (Th) | Titanium (Ti) | Thallium (Tl) | Uranium (U) | Vandium (V) | Tungsten (W) | Yttrium (Y) | Zinc (Zn) | Zirconium (Zr) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Unit | ppm | % | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | % | ppm | ppm | ppm | ppm | ppm | % | ppm |
| | | MDL | 0.002 | 0.01 | 0.5 | 0.1 | 1 | 0.2 | 0.2 | 0.05 | 0.05 | 0.2 | 0.01 | 0.02 | 0.1 | 1 | 0.1 | 0.1 | 0.01 | 0.5 |
| 1 | Sludge Homogenized | Pulp | 0.003 | 5.81 | 0.6 | 0.1 | <1 | <0.2 | 306.1 | <0.05 | <0.05 | <0.2 | <0.01 | 0.16 | 2.70 | 31 | <0.1 | 9.30 | 14.64 | 0.7 |
| 1 R | Sludge Homogenized | Pulp | 0.003 | 5.70 | 0.6 | 0.2 | <1 | <0.2 | 302 | <0.05 | <0.05 | <0.2 | <0.01 | 0.17 | 2.60 | 31 | <0.1 | 9.30 | | 0.8 |
| ***QA/QC:*** | | | | | | | | | | | | | | | | | | | | |
| ***Certified Reference Material:*** | | | | | | | | | | | | | | | | | | | | |
| STD OREAS 601 | | | 0.004 | 1.06 | 29.40 | 4.80 | 12.0 | 4.20 | 237.3 | 1.02 | 15.7 | 12.2 | 0.190 | 1.11 | 4.1 | 27.0 | 5.9 | 11.5 | 1307 | 162.4 |
| **True Value STD OREAS 601** | | | | **1.07** | **30.4** | **4.85** | **12.0** | **4.16** | **230.0** | **1.04** | **16.0** | **11.7** | **0.18** | **1.21** | **4.0** | **25.6** | **5.8** | **11.2** | **1330** | **155.0** |
| % Difference | | | | -0.9 | -3.3 | -1.0 | 0.0 | 1.0 | 3.2 | -1.9 | -1.9 | 4.3 | 5.6 | -8.3 | 2.5 | 5.5 | 1.7 | 2.7 | -1.7 | 4.8 |
| ***Tolerance (%)*** | | | ***NR*** | ***0.04*** | ***2.1*** | ***0.35*** | ***2.9*** | ***0.47*** | ***10*** | ***0.39*** | ***5.3*** | ***1.10*** | ***0.01*** | ***0.05*** | ***0.51*** | ***1.1*** | ***1.17*** | ***1.0*** | ***55*** | ***8*** |
| ***Method Blank:*** | | | | | | | | | | | | | | | | | | | | |
| Method Blank | | | <0.002 | <0.01 | <0.5 | <0.1 | <1 | <0.2 | <0.2 | <0.05 | <0.05 | <0.2 | <0.01 | <0.02 | <0.1 | <1 | <0.1 | <0.1 | <0.01 | <0.5 |

***NOTES:***

Job No: YVR2010304

***Analytical Methods (IMS-230):***

Analytical Method: A 0.25 g of pulp sample is digested with HClO4, HNO3, HCl, HF to 10 mL. (>) Concentration exceeds upper limits.

REE's may not be totally soluble in this method.

While multi-acid digestion is considered to be near total digestion this digestion is only partial for some Cr and Ba minerals and oxides of Al, Fe, Hf, Mn, Sn, Ta and Zr.

Additionally volatilization during fuming may result in some loss of As, S and Sb.

***Abbreviations:***

R / Rep = Replicate (a replicate is a sub-sample scooped from a single sample bag produced per client sample)

D / Dup = Duplicate (a duplicate is 2nd sub-sample bag produced by processing a second split of the original client sample received)

MDL = Measurable Detection Limit

IND = Indeterminate

NR = Not Requested

***On Certified Reference Material and Tolerance:***

Any one element in a run reporting outside tolerance limits does not constitute failure of the standard.

As per Certificate of Analysis (COA): All values indicated are Certified. Values indicated in green are indicative only.

NR = Not Reported (in the Certificate Of Analysis).

***On Tolerance:***

Any one element in a run reporting outside tolerance limits does not constitute failure of the standard.

All "True Values" indicated in green are indicative values as per Certificate Of Analysis (COA) - not certified values.

## CERTIFICATE OF ANALYSIS ▪ RESULTS OF WHOLE ROCK ANALYSIS BY LITHIUM METABORATE FUSION & ICP-AES ANALYSIS (on solids)

Global ARD Testing Services Inc.

**GLOBAL PROJECT NO:** 2011
**CLIENT:** SRK Consulting Inc.
**CLIENT PROJECT NAME / NO:** Faro Sludge Aging Test
**REPORT VERSION:** 6

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Method** | **WRA-310** | | | | | | | | | | | | | |
| **S. No.** | **Sample ID** | **Analyte** | **Al2O3** | **BaO** | **CaO** | **Cr2O3** | **Fe2O3** | **K2O** | **MgO** | **MnO** | **Na2O** | **P2O5** | **SiO2** | **SrO** | **TiO2** | **LOI** | **Total** |
| | | **Units** | **%** | **%** | **%** | **%** | **%** | **%** | **%** | **%** | **%** | **%** | **%** | **%** | **%** | **%** | **%** |
| | | **LOR** | **0.01** | **0.1** | **0.01** | **0.01** | **0.01** | **0.01** | **0.01** | **0.01** | **0.01** | **0.01** | **0.01** | **0.01** | **0.01** | **0.01** | |
| | | **Sample Type** | | | | | | | | | | | | | | | |
| 1 | Sludge Homogenized | Pulp | 0.09 | <0.1 | 13.91 | <0.01 | 9.12 | <0.01 | 12.69 | 2.82 | <0.01 | 0.02 | 1.35 | 0.03 | <0.01 | 28.34 | 68.38 |
| 1 R | Sludge Homogenized | Pulp | 0.10 | <0.1 | 13.79 | <0.01 | 9.03 | <0.01 | 12.65 | 2.81 | <0.01 | 0.02 | 1.30 | 0.04 | <0.01 | 28.36 | 68.09 |
| ***QUALITY ASSURANCE / QUALITY CONTROL*** | | | | | | | | | | | | | | | | | |
| ***Pulp Replicates*** | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| ***Certified Reference Material*** | | | | | | | | | | | | | | | | | |
| STD SY-4 | | | 21.74 | <0.1 | 8.46 | <0.01 | 6.53 | 1.70 | 0.59 | 0.120 | 7.42 | 0.140 | 52.31 | 0.16 | 0.300 | | |
| **True Value STD SY-4** | | | **20.69** | **0.034** | **8.05** | **N/A** | **6.21** | **1.66** | **0.54** | **0.108** | **7.10** | **0.131** | **49.90** | **0.12** | **0.287** | | |
| % Difference (2) | | | 5.07 | | 5.09 | | 5.15 | 2.41 | 9.26 | 11.11 | 4.51 | 6.87 | 4.83 | 34.34 | 4.53 | | |
| ***Tolerance (+/-)*** | | | ***0.08*** | ***0.0005*** | ***0.04*** | | ***0.03*** | ***0.02*** | ***0.01*** | ***0.001*** | ***0.05*** | ***0.004*** | ***0.10*** | ***0.0012*** | ***0.003*** | | |
| ***Method Blank*** | | | | | | | | | | | | | | | | | |
| Method Blank | | | <0.01 | <0.1 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | | |

**Notes:**
Job No: YVR2010304

***Analytical Methods:***
A representative pulp sample is subjected to a $Li_2B_4O_7$ / $LiBO_2$ fusion, followed by ICP analysis for major oxides and LOI (Loss On Ignition by sintering at 1000°C).
A 0.5 g of pulp sample is leached in hot (95°C) 3:1 aqua regia followed by ICP-AES/ICP-MS analysis. Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5 g).

***Abbreviations:***
R / Rep = Replicate (a replicate is a sub-sample scooped from a single sample bag produced per client sample)
D / Dup = Duplicate (a duplicate is 2nd sub-sample bag produced by processing a second split of the original client sample received)
MDL = Measurable Detection Limit
COA: Certificate Of Analysis.
IND = Indeterminate
NR: Not Reported in COA

***On Tolerance:***
Any one element in a run reporting outside tolerance limits does not constitute failure of the standard.
All 'True Values' indicated in green are indicative values as per Certificate Of Analysis (COA) - not certified values.

## CERTIFICATE OF ANALYSIS ▪ TITRATION CURVE

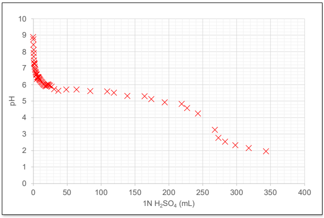


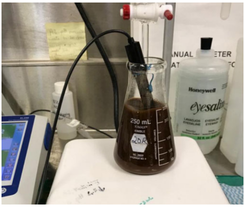
Global ARD Testing Services Inc.

**GLOBAL PROJECT NO:** 2011
**CLIENT:** SRK Consulting Inc.
**CLIENT PROJECT NAME / NO:** Faro Sludge Aging Test
**REPORT VERSION:** 6

**Sample ID:** Sludge Homogenized
**Sample Wt:** 10 g (Dry)
**Acid:** 1N Sulphuric Acid

| 1N H2SO4 (mL) | pH |
|---|---|
| 0 | 8.9 |
| 0.2 | 8.76 |
| 0.4 | 8.42 |
| 0.6 | 8.11 |
| 0.8 | 7.92 |
| 1 | 7.71 |
| 1.2 | 7.47 |
| 1.4 | 7.32 |
| 1.6 | 7.28 |
| 1.8 | 7.28 |
| 2 | 7.24 |
| 2.4 | 7.08 |
| 2.8 | 6.96 |
| 3.2 | 6.89 |
| 3.6 | 6.77 |
| 4 | 6.72 |
| 4.4 | 6.64 |
| 4.8 | 6.61 |
| 5.2 | 6.59 |
| 5.6 | 6.351 |
| 6 | 6.47 |
| 6.4 | 6.46 |
| 6.8 | 6.45 |
| 7.2 | 6.45 |
| 7.6 | 6.44 |
| 8 | 6.4 |
| 8.6 | 6.37 |
| 9.2 | 6.33 |
| 9.8 | 6.28 |
| 10.5 | 6.24 |
| 11.5 | 6.19 |
| 12.5 | 6.16 |
| 13.5 | 6.11 |
| 14.5 | 6.06 |
| 15.5 | 6.01 |
| 16.5 | 5.97 |
| 17.5 | 5.94 |
| 18.5 | 5.89 |
| 19.5 | 5.99 |
| 20.5 | 5.93 |
| 21.5 | 6.01 |
| 22.5 | 5.99 |
| 23.5 | 5.95 |
| 25 | 5.93 |
| 27 | 5.87 |
| 31 | 5.73 |
| 37 | 5.63 |
| 49 | 5.7 |
| 64 | 5.7 |
| 84 | 5.61 |
| 109 | 5.59 |
| 119 | 5.5 |
| 139 | 5.31 |
| 164 | 5.29 |
| 174 | 5.12 |
| 194 | 4.93 |
| 219 | 4.83 |
| 227 | 4.58 |
| 243 | 4.25 |
| 268 | 3.25 |
| 273 | 2.76 |
| 283 | 2.53 |
| 298 | 2.32 |
| 318 | 2.14 |
| 343 | 1.95 |



## CERTIFICATE OF ANALYSIS ▪ CUSTOM SFE (96h)

**Global ARD Testing Services Inc.**

**GLOBAL PROJECT NO:** 2011
**CLIENT:** SRK Consulting Inc.
**CLIENT PROJECT NAME / NO:** Faro Sludge Aging Test
**REPORT VERSION:** 6

| Parameter | Method | Unit | RDL | 1<br>DI Water | 1 R<br>DI Water (Rep) | 2<br>Faro Pit | 3<br>Vangorda Pit | Method Blank |
|---|---|---|---|---|---|---|---|---|
| Weight of dry sample used | Weighing Scale | g | 0.01 | 37.5 | N/A | 37.5 | 37.5 | N/A |
| Volume of water used | Graduated Cylinder | mL | 0.50 | 750 | N/A | 750 | 750 | 750 |
| pH | Meter | pH units | 0.01 | 8.74 | | 8.80 | 8.33 | 4.99 |
| EC | Meter | µS/cm | 1 | 3050 | | 3670 | 4120 | 1.1 |
| ORP | Meter | mV | 1 | 118 | | 50 | 130 | |
| Acidity (to pH 8.3) | Titration | mg $CaCO_3$/L | 0.5 | <0.5 | | <0.5 | <0.5 | |
| Alkalinity (to pH 4.5) | Titration | mg $CaCO_3$/L | 0.5 | 15.5 | | 18.0 | 25.5 | |
| Dissolved Sulphate (SO4) | Colourimetry | mg/L | 50 | 2040 | 2020 | 2510 | 2940 | |
| Chloride | IC | mg/L | 0.05 | 0.49 | 0.49 | 1.57 | 0.7 | |
| Fluoride | SIE | mg/L | 0.02 | 0.34 | 0.32 | 0.41 | 0.46 | |
| Nitrate (as N) | IC | mg/L | 0.005 | 0.019 | 0.019 | 0.193 | 0.165 | |
| Nitrite (as N) | IC | mg/L | 0.005 | 0.111 | 0.118 | 0.099 | 0.124 | |
| ***Dissolved Metals Analysis by ICP-MS:*** | | | | | | | | |
| Dissolved Hardness (CaCO3) | ICP-MS | mg/L | 0.5 | 2000.0 | 1987.0 | 2450.0 | 2910.0 | <0.5 |
| Aluminum Dissolved | ICP-MS | mg/L | 0.001 | <0.001 | <0.001 | <0.001 | 0.003 | <0.001 |
| Antimony Dissolved | ICP-MS | mg/L | 0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Arsenic Dissolved | ICP-MS | mg/L | 0.0002 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | <0.0002 |
| Barium Dissolved | ICP-MS | mg/L | 0.0002 | 0.0092 | 0.0078 | 0.0116 | 0.0152 | <0.0002 |
| Beryllium Dissolved | ICP-MS | mg/L | 0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Bismuth Dissolved | ICP-MS | mg/L | 0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Boron Dissolved | ICP-MS | mg/L | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Cadmium Dissolved | ICP-MS | mg/L | 0.00001 | 0.00008 | 0.00009 | 0.00013 | 0.00137 | <0.00001 |
| Calcium Dissolved | ICP-MS | mg/L | 0.05 | 479.0 | 474 | 449.0 | 445.0 | <0.05 |
| Chromium Dissolved | ICP-MS | mg/L | 0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Cobalt Dissolved | ICP-MS | mg/L | 0.0001 | 0.0006 | 0.0006 | 0.001 | 0.0154 | <0.0001 |
| Copper Dissolved | ICP-MS | mg/L | 0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Iron Dissolved | ICP-MS | mg/L | 0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Lead Dissolved | ICP-MS | mg/L | 0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Lithium Dissolved | ICP-MS | mg/L | 0.0005 | 0.0109 | 0.0102 | 0.0736 | 0.0520 | <0.0005 |
| Magnesium Dissolved | ICP-MS | mg/L | 0.05 | 195.0 | 196 | 323.0 | 436.0 | <0.005 |
| Manganese Dissolved | ICP-MS | mg/L | 0.0002 | 0.0007 | 0.0006 | 0.0151 | 5.73 | <0.0002 |
| Mercury Dissolved | ICP-MS | mg/L | 0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Molybdenum Dissolved | ICP-MS | mg/L | 0.0001 | 0.0002 | 0.0002 | 0.0002 | 0.0001 | <0.0001 |
| Nickel Dissolved | ICP-MS | mg/L | 0.0005 | <0.0005 | <0.0005 | 0.0008 | 0.0101 | <0.0005 |
| Phosphorus Dissolved | ICP-MS | mg/L | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Potassium Dissolved | ICP-MS | mg/L | 0.05 | 1.3 | 1.29 | 11.2 | 4.27 | <0.05 |
| Selenium Dissolved | ICP-MS | mg/L | 0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Silicon Dissolved | ICP-MS | mg/L | 0.05 | 0.2 | 0.20 | 0.23 | 0.34 | <0.05 |
| Silver Dissolved | ICP-MS | mg/L | 0.00008 | <0.00008 | <0.00008 | <0.00008 | <0.00008 | <0.00008 |
| Sodium Dissolved | ICP-MS | mg/L | 0.02 | 3.51 | 3.44 | 27.3 | 10.5 | <0.02 |
| Strontium Dissolved | ICP-MS | mg/L | 0.0002 | 2.89 | 2.89 | 3.13 | 3.26 | <0.0002 |
| Sulphur Dissolved | ICP-MS | mg/L | 0.5 | 642.0 | 643 | 748.0 | 894.0 | <0.5 |
| Tellurium Dissolved | ICP-MS | mg/L | 0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 |
| Thallium Dissolved | ICP-MS | mg/L | 0.00005 | 0.00209 | 0.00218 | 0.00323 | 0.003 | <0.00005 |
| Thorium Dissolved | ICP-MS | mg/L | 0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Tin Dissolved | ICP-MS | mg/L | 0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Titanium Dissolved | ICP-MS | mg/L | 0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Tungsten Dissolved | ICP-MS | mg/L | 0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Uranium Dissolved | ICP-MS | mg/L | 0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| Vanadium Dissolved | ICP-MS | mg/L | 0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Zinc Dissolved | ICP-MS | mg/L | 0.001 | 0.049 | 0.050 | 0.059 | 0.125 | <0.001 |
| Zirconium Dissolved | ICP-MS | mg/L | 0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| ***Ion Balance:*** | | | | | | | | |
| Major Anions | Calc. | meq/L | | 42.85 | 42.12 | 52.74 | 61.83 | |
| Major Cations | Calc. | meq/L | | 40.20 | 40.03 | 50.53 | 58.93 | |
| Difference | Calc. | meq/L | | -2.65 | -2.10 | -2.21 | -2.90 | |
| Balance (%) | Calc. | % | | -3.2% | -2.6% | -2.1% | -2.4% | |
| | | | *Shake Flask Extract ID:* | *1087001* | *1087001* | *1087006* | *1087007* | *1087009* |

***NOTES:***
Job No: 20V594520
**Date of Analysis (24 h):** April 16-21, 2020
pH of DI water used (pH Units): 5.60
EC of DI water used (µS/cm): 0.74
***ABBREVIATIONS:***
R / Rep = Replicate (which involves the analysis of the same Shake Flask Extract aliquot).
D / Dup = Duplicate (which involves the analysis of a separate SF extract, produced by processing a secopnd split of the original client sample received).
Calc. = Calculation
EC = Electrical Conductivity
IC = Ion Chromatography
N/A = Not Applicable.
mg/L = Milligrams per Litre
***REFERENCE:***
**Extraction Method used:** Gentle stirring by hand every 12h for 96h.
**Liquid: Solid ratio used:** 20: 1; L: S; 750 mL: 37.5 g of dry sludge.

## CERTIFICATE OF ANALYSIS ▪ OXIC AGING TEST

**Global ARD Testing Services Inc.**

**GLOBAL PROJECT NO:** 2011
**CLIENT:** SRK Consulting Inc.
**CLIENT PROJECT NAME / NO:** Faro Sludge Aging Test
**REPORT VERSION:** 6

| Parameter | Method | Unit | RDL | Blank | 0.5h | 1h | 1.5h | 2h | 3h | 4h | 5h | 6h | 7h | 2 week | 1 month | 2 month | 3 month | 4 month | 7 month |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Sample ID | | | | | | | | | | | | | | | |
| | | | | Oxic_DI_pH4 | | | | | | | | | | | | | | | |
| Weight of dry sample used | Weighing Scale | g | 0.01 | | | | | | | | | | | 25 | 25 | 25 | 25 | 25 | 25 |
| Volume of water used | Graduated Cylinder | mL | 0.50 | | | | | | | | | | | 475 | 475 | 475 | 475 | 475 | 475 |
| pH (Undisturbed) | Meter | pH units | 0.01 | 4.1 | 8.9 | 9.2 | 9.2 | 9.1 | 8.9 | 8.9 | 8.9 | 8.9 | 8.8 | 7.5 | 7.7 | 7.7 | 7.7 | 6.4 | 6.1 |
| pH (Stirred) | Meter | pH units | 0.01 | | | | | | | | | | | 8.6 | 8.8 | 8.5 | 8.3 | 7.3 | 7.1 |
| pH (Filtered) | Meter | pH units | 0.01 | | | | | | | | | | | 8.7 | 8.5 | 8.4 | 7.2 | 7.3 | 7.0 |
| EC (Undisturbed) | Meter | µS/cm | 1 | 56 | 1124 | 1252 | 1246 | 1245 | 1265 | 1275 | 1265 | 1264 | 1263 | 1504 | 2500 | 3400 | 3960 | 3600 | 3810 |
| EC (Stirred) | Meter | µS/cm | 1 | | | | | | | | | | | 2820 | 3380 | 3520 | 4220 | 3830 | 3930 |
| EC (Filtered) | Meter | µS/cm | 1.00 | | | | | | | | | | | 2930 | 3400 | 3700 | 5550 | 4080 | 4020 |
| ORP (Undisturbed) | Meter | mV | 1 | 369 | 25 | 31 | 27 | 35 | 41 | 42 | 40 | 42 | 41 | 215 | 243 | 240 | 253 | 225 | 220 |
| ORP (Stirred) | Meter | mV | 1 | | | | | | | | | | | 112 | 160 | 180 | 200 | 219 | 222 |
| ORP (Unfiltered) | Meter | mV | 1.00 | | | | | | | | | | | 114 | 161 | 180 | 256 | 229 | 228 |
| Dissolved Oxygen | Meter | mg/L | 1 | 8.9 | | | | | | | | | | | | | | | |
| Acidity (to pH 8.3) | Titration | mg $CaCO_3$/L | 0.5 | | | | | | | | | | | <0.5 | <0.5 | <0.5 | 14.4 | 5.0 | 4.2 |
| Alkalinity (to pH 4.5) | Titration | mg $CaCO_3$/L | 0.5 | | | | | | | | | | | 26.5 | 24.0 | 23.0 | 20.5 | 17.5 | 19.4 |
| Dissolved Sulphate (SO4) | Colourimetry | mg/L | 50 | | | | | | | | | | | 2200 | 2270 | 2355 | 2490 | 2880 | 2940 |
| Chloride | IC | mg/L | 0.5 | | | | | | | | | | | 0.5 | 0.7 | 0.7 | 1.0 | 0.6 | 0.6 |
| Fluoride | SIE | mg/L | 0.2 | | | | | | | | | | | 0.30 | 0.30 | <0.2 | <0.2 | <0.2 | <0.2 |
| Bromide | SIE | mg/L | 0.5 | | | | | | | | | | | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Nitrate (as N) | IC | mg/L | 0.05 | | | | | | | | | | | <0.05 | 0.190 | <0.05 | 0.050 | <0.05 | <0.05 |
| Nitrite (as N) | IC | mg/L | 0.05 | | | | | | | | | | | 0.08 | 0.1 | 0.08 | 0.1 | 0.1 | 0.1 |
| Ammonia (as N) | Colourimetry | mg/L | 0.01 | | | | | | | | | | | 1.29 | 1.020 | 1.040 | 1.090 | 1.02 / 1.05 | 1.02 |
| ***Dissolved Metals Analysis by ICP-MS:*** | | | | | | | | | | | | | | | | | | | |
| Dissolved Hardness (CaCO3) | ICP-MS | mg/L | 0.5 | | | | | | | | | | | 1910 | 2450 | 2540 | 2760 | 3020 | 3140 |
| Aluminum Dissolved | ICP-MS | mg/L | 0.001 | | | | | | | | | | | 0.002 | 0.001 | 0.001 | <0.001 | 0.002 | 0.004 |
| Antimony Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Arsenic Dissolved | ICP-MS | mg/L | 0.0002 | | | | | | | | | | | <0.0002 | <0.0002 | <0.0002 | <0.0002 | 0.001 | 0.002 |
| Barium Dissolved | ICP-MS | mg/L | 0.0002 | | | | | | | | | | | 0.0017 | 0.0029 | 0.0033 | 0.0037 | 0.006 | 0.009 |
| Beryllium Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | 0.0001 | 0.0001 |
| Bismuth Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Boron Dissolved | ICP-MS | mg/L | 0.01 | | | | | | | | | | | <0.01 | <0.01 | <0.01 | <0.01 | 0.01 | 0.01 |
| Cadmium Dissolved | ICP-MS | mg/L | 0.00001 | | | | | | | | | | | 0.00007 | 0.00009 | 0.00009 | 0.00024 | 0.00012 | 0.00012 |
| Calcium Dissolved | ICP-MS | mg/L | 0.05 | | | | | | | | | | | 293 | 323 | 344 | 399 | 463 | 482 |
| Chromium Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | 0.001 | <0.0005 | <0.0005 | <0.0005 | 0.0006 | 0.0009 |
| Cobalt Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | 0.0003 | 0.0007 | 0.0007 | 0.002 | 0.0009 | 0.0008 |
| Copper Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | <0.0005 | 0.0006 | 0.0006 | <0.0005 | <0.0005 | <0.0005 |
| Iron Dissolved | ICP-MS | mg/L | 0.02 | | | | | | | | | | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Lead Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Lithium Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | 0.0102 | 0.0098 | 0.0098 | 0.0103 | 0.0122 | 0.0146 |
| Magnesium Dissolved | ICP-MS | mg/L | 0.05 | | | | | | | | | | | 285 | 399 | 414 | 429 | 453 | 472 |
| Manganese Dissolved | ICP-MS | mg/L | 0.0002 | | | | | | | | | | | 0.0024 | 0.0034 | 0.0034 | 0.0216 | 0.0042 | 0.0055 |
| Mercury Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Molybdenum Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | 0.0005 | 0.0003 | 0.0003 | 0.0002 | 0.0003 | 0.0003 |
| Nickel Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | <0.0005 | 0.0009 | 0.0012 | 0.0027 | 0.0009 | 0.0016 |
| Phosphorus Dissolved | ICP-MS | mg/L | 0.05 | | | | | | | | | | | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Potassium Dissolved | ICP-MS | mg/L | 0.05 | | | | | | | | | | | 1.42 | 1.59 | 1.59 | 1.55 | 1.64 | 1.61 |
| Selenium Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Silicon Dissolved | ICP-MS | mg/L | 0.05 | | | | | | | | | | | 0.16 | 0.24 | 0.24 | 0.41 | 0.28 | 0.26 |
| Silver Dissolved | ICP-MS | mg/L | 0.00008 | | | | | | | | | | | <0.00008 | <0.00008 | <0.00008 | <0.00008 | <0.00008 | <0.00008 |
| Sodium Dissolved | ICP-MS | mg/L | 0.02 | | | | | | | | | | | 3.79 | 4.15 | 4.47 | 4.57 | 5.01 | 5.33 |
| Strontium Dissolved | ICP-MS | mg/L | 0.0002 | | | | | | | | | | | 0.901 | 1.02 | 1.2 | 1.34 | 1.37 | 1.35 |
| Sulphur Dissolved | ICP-MS | mg/L | 2.5 | | | | | | | | | | | 709 | 762 | 788 | 879 | 985 | 966 |
| Tellurium Dissolved | ICP-MS | mg/L | 0.0002 | | | | | | | | | | | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 |
| Thallium Dissolved | ICP-MS | mg/L | 0.00005 | | | | | | | | | | | 0.00231 | 0.00302 | 0.00302 | 0.00321 | 0.0034 | 0.0033 |
| Thorium Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Tin Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Titanium Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | 0.0008 | <0.0005 |
| Tungsten Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | 0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Uranium Dissolved | ICP-MS | mg/L | 0.00005 | | | | | | | | | | | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| Vanadium Dissolved | ICP-MS | mg/L | 0.001 | | | | | | | | | | | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Zinc Dissolved | ICP-MS | mg/L | 0.001 | | | | | | | | | | | 0.059 | 0.084 | 0.192 | 0.374 | 0.137 | 0.211 |
| Zirconium Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| ***Ion Balance:*** | | | | | | | | | | | | | | | | | | | |
| Major Anions | Calc. | meq/L | | | | | | | | | | | | 46.39 | 47.82 | 49.54 | 52.32 | 60.37 | 61.65 |
| Major Cations | Calc. | meq/L | | | | | | | | | | | | 38.29 | 49.19 | 51.49 | 55.49 | 60.67 | 63.19 |
| Difference | Calc. | meq/L | | | | | | | | | | | | -8.10 | 1.37 | 1.95 | 3.17 | 0.30 | 1.54 |
| Balance (%) | Calc. | % | | | | | | | | | | | | -9.6% | 1.4% | 1.9% | 2.9% | 0.2% | 1.2% |

***NOTES:***
**Date of Analysis / COA:**
**Start:** April 27, 2020 / NA
**2 weeks:** May 11, 2020 / 20V600583

## CERTIFICATE OF ANALYSIS ▪ OXIC AGING TEST

Global ARD Testing Services Inc.

**GLOBAL PROJECT NO:** 2011
**CLIENT:** SRK Consulting Inc.
**CLIENT PROJECT NAME / NO:** Faro Sludge Aging Test
**REPORT VERSION:** 6

| Parameter | Method | Unit | RDL | Blank | 0.5h | 1h | 1.5h | 2h | 3h | 4h | 5h | 6h | 7h | 2 week | 1 month | 2 month | 3 month | 4 month | 7 month |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Sample ID | | | | | | | | | | | | | | | |
| | | | | Oxic_DI_pH7 | | | | | | | | | | | | | | | |
| Weight of dry sample used | Weighing Scale | g | 0.01 | | | | | | | | | | | 25 | 25 | 25 | 25 | 25 | 25 |
| Volume of water used | Graduated Cylinder | mL | 0.50 | | | | | | | | | | | 475 | 475 | 475 | 475 | 475 | 475 |
| pH (Undisturbed) | Meter | pH units | 0.01 | 7.1 | 9.2 | 9.2 | 9.1 | 9.0 | 8.9 | 8.9 | 8.9 | 8.9 | 8.9 | 7.7 | 7.9 | 7.7 | 7.7 | 7.1 | 6.5 |
| pH (Sitrred) | Meter | pH units | 0.01 | | | | | | | | | | | 8.8 | 8.8 | 8.4 | 8.3 | 8.3 | 7.8 |
| pH (Filtered) | Meter | pH units | 0.01 | | | | | | | | | | | 8.6 | 8.5 | 8.3 | 7.4 | 7.4 | 7.2 |
| EC (Undisturbed) | Meter | µS/cm | 1 | 12 | 1197 | 1182 | 1139 | 1144 | 1186 | 1185 | 1187 | 1189 | 1187 | 1670 | 2430 | 2930 | 3980 | 3520 | 3730 |
| EC (Stirred) | Meter | µS/cm | 1 | | | | | | | | | | | 1830 | 3420 | 3470 | 4070 | 3750 | 3940 |
| EC (Filtered) | Meter | µS/cm | 1.00 | | | | | | | | | | | 1920 | 3450 | 3660 | 4370 | 4075 | 4055 |
| ORP (Undisturbed) | Meter | mV | 1 | 206 | 17 | 10 | 18 | 22 | 23 | 41 | 41 | 42 | 42 | 207 | 243 | 251 | 250 | 228 | 221 |
| ORP (Stirred) | Meter | mV | 1 | | | | | | | | | | | 145 | 164 | 205 | 217 | 222 | 226 |
| ORP (Unfiltered) | Meter | mV | 1.00 | | | | | | | | | | | 147 | 163 | 200 | 261 | 226 | 224 |
| Dissolved Oxygen | Meter | mg/L | 1 | 8.9 | | | | | | | | | | | | | | | |
| Acidity (to pH 8.3) | Titration | mg $CaCO_3$/L | 0.5 | | | | | | | | | | | <0.5 | <0.5 | <0.5 | 10.0 | 5.0 | 3.7 |
| Alkalinity (to pH 4.5) | Titration | mg $CaCO_3$/L | 0.5 | | | | | | | | | | | 22.5 | 24.0 | 26.5 | 20.6 | 17.5 | 18.9 |
| Dissolved Sulphate (SO4) | Colourimetry | mg/L | 50 | | | | | | | | | | | 2140 | 2220 | 2350 | 2650 | 2810 | 3050 |
| Chloride | IC | mg/L | 0.5 | | | | | | | | | | | 0.6 | 0.5 | 0.5 | 1.0 | 0.7 | 0.8 |
| Fluoride | SIE | mg/L | 0.2 | | | | | | | | | | | 0.30 | 0.20 | <0.2 | <0.2 | <0.2 | <0.2 |
| Bromide | SIE | mg/L | 0.2 | | | | | | | | | | | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Nitrate (as N) | IC | mg/L | 0.05 | | | | | | | | | | | 0.050 | 0.170 | <0.05 | <0.05 | <0.05 | <0.05 |
| Nitrite (as N) | IC | mg/L | 0.05 | | | | | | | | | | | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 |
| Ammonia (as N) | Colourimetry | mg/L | 0.01 | | | | | | | | | | | 1.250 | 1.09 | 1.10 | 1.10 | 1.04 | 1.02 |
| ***Dissolved Metals Analysis by ICP-MS:*** | | | | | | | | | | | | | | | | | | | |
| Dissolved Hardness (CaCO3) | ICP-MS | mg/L | 0.5 | | | | | | | | | | | 1910 | 2420 | 2620 | 2750 | 2960 | 3060 |
| Aluminum Dissolved | ICP-MS | mg/L | 0.001 | | | | | | | | | | | <0.001 | 0.007 | <0.001 | <0.001 | 0.002 | 0.003 |
| Antimony Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Arsenic Dissolved | ICP-MS | mg/L | 0.0002 | | | | | | | | | | | <0.0002 | <0.0002 | <0.0002 | <0.0002 | 0.0008 | 0.0011 |
| Barium Dissolved | ICP-MS | mg/L | 0.0002 | | | | | | | | | | | 0.0055 | 0.0008 | 0.0012 | 0.0068 | 0.0061 | 0.0067 |
| Beryllium Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | 0.0003 | 0.0005 |
| Bismuth Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Boron Dissolved | ICP-MS | mg/L | 0.01 | | | | | | | | | | | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Cadmium Dissolved | ICP-MS | mg/L | 0.00001 | | | | | | | | | | | 0.00007 | 0.0001 | 0.00015 | 0.00034 | 0.0001 | 0.00022 |
| Calcium Dissolved | ICP-MS | mg/L | 0.05 | | | | | | | | | | | 289 | 325 | 357 | 397 | 444 | 477 |
| Chromium Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | 0.0007 | <0.0005 | <0.0005 | <0.0005 | 0.0007 | 0.0009 |
| Cobalt Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | 0.0011 | 0.0006 | 0.0009 | 0.002 | 0.0013 | 0.0019 |
| Copper Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | <0.0005 | 0.0006 | <0.0005 | <0.0005 | 0.0014 | 0.0018 |
| Iron Dissolved | ICP-MS | mg/L | 0.02 | | | | | | | | | | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Lead Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Lithium Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | 0.0096 | 0.0103 | 0.011 | 0.01 | 0.0115 | 0.0124 |
| Magnesium Dissolved | ICP-MS | mg/L | 0.05 | | | | | | | | | | | 289 | 390 | 404 | 426 | 450 | 462 |
| Manganese Dissolved | ICP-MS | mg/L | 0.0002 | | | | | | | | | | | 0.0064 | 0.004 | 0.0141 | 0.0237 | 0.0148 | 0.0183 |
| Mercury Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Molybdenum Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | 0.0003 | 0.0003 | 0.0003 | 0.0001 | 0.0003 | 0.0005 |
| Nickel Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | <0.0005 | 0.0014 | 0.0014 | 0.0025 | 0.0016 | 0.0021 |
| Phosphorus Dissolved | ICP-MS | mg/L | 0.05 | | | | | | | | | | | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Potassium Dissolved | ICP-MS | mg/L | 0.05 | | | | | | | | | | | 1.38 | 1.49 | 1.47 | 1.46 | 1.57 | 1.66 |
| Selenium Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Silicon Dissolved | ICP-MS | mg/L | 0.05 | | | | | | | | | | | 0.19 | 0.23 | 0.32 | 0.43 | 0.38 | 0.4 |
| Silver Dissolved | ICP-MS | mg/L | 0.00008 | | | | | | | | | | | <0.00008 | <0.00008 | <0.00008 | <0.00008 | <0.00008 | <0.00008 |
| Sodium Dissolved | ICP-MS | mg/L | 0.02 | | | | | | | | | | | 5.84 | 5.98 | 6.14 | 6.35 | 6.81 | 7.06 |
| Strontium Dissolved | ICP-MS | mg/L | 0.0002 | | | | | | | | | | | 0.908 | 1.05 | 1.12 | 1.35 | 1.3 | 1.33 |
| Sulphur Dissolved | ICP-MS | mg/L | 2.5 | | | | | | | | | | | 686 | 738 | 782 | 895 | 964 | 1006 |
| Tellurium Dissolved | ICP-MS | mg/L | 0.0002 | | | | | | | | | | | <0.0002 | <0.0002 | <0.0002 | <0.0002 | 0.0003 | 0.0002 |
| Thallium Dissolved | ICP-MS | mg/L | 0.00005 | | | | | | | | | | | 0.00241 | 0.00313 | 0.00311 | 0.0033 | 0.0036 | 0.0041 |
| Thorium Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Tin Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Titanium Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | 0.0008 | 0.0007 |
| Tungsten Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Uranium Dissolved | ICP-MS | mg/L | 0.00005 | | | | | | | | | | | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| Vanadium Dissolved | ICP-MS | mg/L | 0.001 | | | | | | | | | | | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Zinc Dissolved | ICP-MS | mg/L | 0.001 | | | | | | | | | | | 0.089 | 0.089 | 0.194 | 0.483 | 0.358 | 0.411 |
| Zirconium Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| ***Ion Balance:*** | | | | | | | | | | | | | | | | | | | |
| Major Anions | Calc. | meq/L | | | | | | | | | | | | 45.07 | 46.77 | 49.50 | 55.65 | 58.91 | 63.94 |
| Major Cations | Calc. | meq/L | | | | | | | | | | | | 38.51 | 48.63 | 51.39 | 55.22 | 59.56 | 62.21 |
| Difference | Calc. | meq/L | | | | | | | | | | | | -6.56 | 1.86 | 1.89 | -0.43 | 0.64 | -1.74 |
| Balance (%) | Calc. | % | | | | | | | | | | | | -7.8% | 2.0% | 1.9% | -0.4% | 0.5% | -1.4% |

***NOTES:***
**Date of Analysis / COA:**
**Start:** April 27, 2020 / NA
**2 weeks:** May 11, 2020 / 20V600583

## CERTIFICATE OF ANALYSIS ▪ OXIC AGING TEST

Global ARD Testing Services Inc.

**GLOBAL PROJECT NO:** 2011
**CLIENT:** SRK Consulting Inc.
**CLIENT PROJECT NAME / NO:** Faro Sludge Aging Test
**REPORT VERSION:** 6

| Parameter | Method | Unit | RDL | Blank | 0.5h | 1h | 1.5h | 2h | 3h | 4h | 5h | 6h | 7h | 2 week | 1 month | 2 month | 3 month | 4 month | 7 month |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Sample ID | | | | | | | | | | | | | | | |
| | | | | Oxic_Faro | | | | | | | | | | | | | | | |
| Weight of dry sample used | Weighing Scale | g | 0.01 | | 25 | | | | | | | | | | 25 | 25 | 25 | 25 | 25 |
| Volume of water used | Graduated Cylinder | mL | 0.50 | | 475 | | | | | | | | | | 475 | 475 | 475 | 475 | 475 |
| pH (Undisturbed) | Meter | pH units | 0.01 | 6.8 | 7.6 | 8.3 | 7.4 | 7.6 | 7.5 | 7.5 | 7.4 | 7.4 | 7.4 | 7.5 | 7.8 | 7.8 | 7.8 | 7.2 | 6.4 |
| pH (Stirred) | Meter | pH units | 0.01 | | | | | | | | | | | 8.1 | 8.5 | 8.2 | 8.2 | 7.4 | 7.0 |
| pH (Filtered) | Meter | pH units | 0.01 | | | | | | | | | | | 8.0 | 8.6 | 8.3 | 7.6 | 7.4 | 6.9 |
| EC (Undisturbed) | Meter | µS/cm | 1 | 1904 | 2550 | 2570 | 2590 | 2530 | 2560 | 2590 | 2550 | 2550 | 2550 | 2800 | 3690 | 3820 | 4860 | 4250 | 4690 |
| EC (Stirred) | Meter | µS/cm | 1 | | | | | | | | | | | 3910 | 4320 | 4410 | 4950 | 4380 | 4770 |
| EC (Filtered) | Meter | µS/cm | 1.00 | | | | | | | | | | | 3930 | 4340 | 4210 | 5310 | 4850 | 4810 |
| ORP (Undisturbed) | Meter | mV | 1 | 215 | 57 | 58 | 57 | 69 | 64 | 76 | 74 | 78 | 81 | 208 | 244 | 240 | 239 | 218 | 224 |
| ORP (Stirred) | Meter | mV | 1 | | | | | | | | | | | 118 | 170 | 205 | 220 | 218 | 220 |
| ORP (Unfiltered) | Meter | mV | 1.00 | | | | | | | | | | | 122 | 178 | 183 | 252 | 225 | 226 |
| Dissolved Oxygen | Meter | mg/L | 1 | 8.9 | | | | | | | | | | | | | | | |
| Acidity (to pH 8.3) | Titration | mg $CaCO_3$/L | 0.5 | | | | | | | | | | | 8.5 | <0.5 | <0.5 | 10.6 | 5.0 | 3.4 |
| Alkalinity (to pH 4.5) | Titration | mg $CaCO_3$/L | 0.5 | | | | | | | | | | | 48.0 | 36.5 | 34.5 | 25.6 | 17.5 | 18.8 |
| Dissolved Sulphate (SO4) | Colourimetry | mg/L | 50 | | | | | | | | | | | 2870 | 2950 | 3050 | 3250 | 3410 | 3540 |
| Chloride | IC | mg/L | 0.5 | | | | | | | | | | | 2.2 | 2.3 | 1.9 | 1.3 | 1.7 | 1.6 |
| Fluoride | SIE | mg/L | 0.2 | | | | | | | | | | | 0.50 | 0.40 | 0.50 | 0.50 | 0.20 | 0.50 |
| Bromide | SIE | mg/L | 0.2 | | | | | | | | | | | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Nitrate (as N) | IC | mg/L | 0.05 | | | | | | | | | | | 0.410 | 0.220 | 0.240 | 0.290 | 0.200 | 0.172 |
| Nitrite (as N) | IC | mg/L | 0.05 | | | | | | | | | | | 0.1 | 0.1 | 0.2 | 0.3 | 0.1 | 0.1 |
| Ammonia (as N) | Colourimetry | mg/L | 0.01 | | | | | | | | | | | 1.700 | 1.860 | 1.750 | 1.700 | 1.570 | 1.490 |
| ***Dissolved Metals Analysis by ICP-MS:*** | | | | | | | | | | | | | | | | | | | |
| Dissolved Hardness (CaCO3) | ICP-MS | mg/L | 0.5 | | | | | | | | | | | 2760 | 3090 | 3210 | 3440 | 3490 | 3610 |
| Aluminum Dissolved | ICP-MS | mg/L | 0.001 | | | | | | | | | | | <0.001 | <0.001 | <0.001 | <0.001 | 0.001 | 0.003 |
| Antimony Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Arsenic Dissolved | ICP-MS | mg/L | 0.0002 | | | | | | | | | | | <0.0002 | <0.0002 | <0.0002 | <0.0002 | 0.0008 | 0.0011 |
| Barium Dissolved | ICP-MS | mg/L | 0.0002 | | | | | | | | | | | 0.0096 | 0.007 | 0.008 | 0.0088 | 0.0081 | 0.0096 |
| Beryllium Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | 0.0001 | 0.00016 |
| Bismuth Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Boron Dissolved | ICP-MS | mg/L | 0.01 | | | | | | | | | | | <0.01 | <0.01 | <0.01 | <0.01 | 0.01 | 0.013 |
| Cadmium Dissolved | ICP-MS | mg/L | 0.00001 | | | | | | | | | | | 0.00084 | 0.0003 | 0.0003 | 0.00022 | 0.00017 | 0.00019 |
| Calcium Dissolved | ICP-MS | mg/L | 0.25 | | | | | | | | | | | 355 | 387 | 399 | 434 | 441 | 455 |
| Chromium Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | 0.0011 | 0.0016 |
| Cobalt Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | 0.0083 | 0.003 | 0.005 | 0.0073 | 0.0025 | 0.0062 |
| Copper Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | <0.0005 | 0.0011 | 0.0005 | 0.0005 | 0.0009 | 0.0014 |
| Iron Dissolved | ICP-MS | mg/L | 0.02 | | | | | | | | | | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Lead Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Lithium Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | 0.073 | 0.0715 | 0.071 | 0.0705 | 0.0855 | 0.0896 |
| Magnesium Dissolved | ICP-MS | mg/L | 0.5 | | | | | | | | | | | 455 | 515 | 537 | 572 | 581 | 593 |
| Manganese Dissolved | ICP-MS | mg/L | 0.002 | | | | | | | | | | | 3.95 | 1.77 | 0.91 | 0.54 | 0.0786 | 0.0732 |
| Mercury Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Molybdenum Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | 0.0002 | 0.0003 | 0.0003 | 0.0001 | 0.0002 | 0.0002 |
| Nickel Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | 0.0141 | 0.0057 | 0.0066 | 0.0092 | 0.0034 | 0.0029 |
| Phosphorus Dissolved | ICP-MS | mg/L | 0.05 | | | | | | | | | | | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Potassium Dissolved | ICP-MS | mg/L | 0.05 | | | | | | | | | | | 11.8 | 12.4 | 12 | 11.4 | 11.3 | 11.6 |
| Selenium Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Silicon Dissolved | ICP-MS | mg/L | 0.05 | | | | | | | | | | | 0.85 | 0.6 | 0.61 | 0.66 | 0.36 | 0.44 |
| Silver Dissolved | ICP-MS | mg/L | 0.00008 | | | | | | | | | | | <0.00008 | 0.00017 | <0.00008 | <0.00008 | <0.00008 | <0.00008 |
| Sodium Dissolved | ICP-MS | mg/L | 0.02 | | | | | | | | | | | 27.8 | 28.1 | 28 | 28.2 | 28.9 | 29.1 |
| Strontium Dissolved | ICP-MS | mg/L | 0.0002 | | | | | | | | | | | 1.31 | 1.5 | 1.6 | 1.59 | 1.46 | 1.4 |
| Sulphur Dissolved | ICP-MS | mg/L | 2.5 | | | | | | | | | | | 894 | 934 | 1010 | 1070 | 1150 | 1185 |
| Tellurium Dissolved | ICP-MS | mg/L | 0.0002 | | | | | | | | | | | <0.0002 | <0.0002 | <0.0002 | <0.0002 | 0.0002 | 0.0003 |
| Thallium Dissolved | ICP-MS | mg/L | 0.00005 | | | | | | | | | | | 0.00287 | 0.00355 | 0.00391 | 0.00433 | 0.00438 | 0.00447 |
| Thorium Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Tin Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Titanium Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | <0.0005 | 0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Tungsten Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Uranium Dissolved | ICP-MS | mg/L | 0.00005 | | | | | | | | | | | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| Vanadium Dissolved | ICP-MS | mg/L | 0.001 | | | | | | | | | | | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Zinc Dissolved | ICP-MS | mg/L | 0.001 | | | | | | | | | | | 0.447 | 0.158 | 0.469 | 0.595 | 0.238 | 0.223 |
| Zirconium Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| ***Ion Balance:*** | | | | | | | | | | | | | | | | | | | |
| Major Anions | Calc. | meq/L | | | | | | | | | | | | 60.87 | 62.29 | 64.33 | 68.30 | 71.46 | 74.21 |
| Major Cations | Calc. | meq/L | | | | | | | | | | | | 56.85 | 63.32 | 65.70 | 70.31 | 71.39 | 73.10 |
| Difference | Calc. | meq/L | | | | | | | | | | | | -4.02 | 1.03 | 1.37 | 2.00 | -0.07 | -1.11 |
| Balance (%) | Calc. | % | | | | | | | | | | | | -3.4% | 0.8% | 1.1% | 1.4% | 0.0% | -0.8% |

***NOTES:***
**Date of Analysis / COA:**
**Start:** April 27, 2020 / NA
**2 weeks:** May 11, 2020 / 20V600583

## CERTIFICATE OF ANALYSIS ▪ OXIC AGING TEST

**Global ARD Testing Services Inc.**

**GLOBAL PROJECT NO:** 2011
**CLIENT:** SRK Consulting Inc.
**CLIENT PROJECT NAME / NO:** Faro Sludge Aging Test
**REPORT VERSION:** 6

| Parameter | Method | Unit | RDL | Blank | 0.5h | 1h | 1.5h | 2h | 3h | 4h | 5h | 6h | 7h | 2 week | 1 month | 2 month | 3 month | 4 month | 7 month |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Sample ID | | | | | | | | | | | | | | | |
| | | | | Oxic_Vangorda | | | | | | | | | | | | | | | |
| Weight of dry sample used | Weighing Scale | g | 0.01 | | | | | | | | | | | 25 | 25 | 25 | 25 | 25 | 25 |
| Volume of water used | Graduated Cylinder | mL | 0.50 | | | | | | | | | | | 475 | 475 | 475 | 475 | 475 | 475 |
| pH (Undisturbed) | Meter | pH units | 0.01 | 3.5 | 6.3 | 7.3 | 6.2 | 6.7 | 6.2 | 6.2 | 6.2 | 6.1 | 6.1 | 5.7 | 7.8 | 7.6 | 7.6 | 7.2 | 6.5 |
| pH (Sitrred) | Meter | pH units | 0.01 | | | | | | | | | | | 6.9 | 8.5 | 8.0 | 7.8 | 7.6 | 7.2 |
| pH (Filtered) | Meter | pH units | 0.01 | | | | | | | | | | | 7.2 | 8.6 | 8.3 | 7.3 | 7.7 | 7.3 |
| EC (Undisturbed) | Meter | µS/cm | 1 | 2790 | 3310 | 3270 | 3290 | 3300 | 3210 | 3230 | 3280 | 3300 | 3310 | 3340 | 3690 | 4020 | 5500 | 4730 | 5050 |
| EC (Stirred) | Meter | µS/cm | 1 | | | | | | | | | | | 4570 | 4320 | 440 | 5390 | 5080 | 5210 |
| EC (Filtered) | Meter | µS/cm | 1.00 | | | | | | | | | | | 4610 | 4340 | 4490 | 5910 | 5380 | 5290 |
| ORP (Undisturbed) | Meter | mV | 1 | 328 | 11 | 1 | 9 | 12 | 14 | 32 | 29 | 33 | 35 | 247 | 244 | 248 | 253 | 216 | 210 |
| ORP (Stirred) | Meter | mV | 1 | | | | | | | | | | | 165 | 170 | 221 | 240 | 212 | 207 |
| ORP (Unfiltered) | Meter | mV | 1.00 | | | | | | | | | | | 166 | 178 | 193 | 260 | 214 | 209 |
| Dissolved Oxygen | Meter | mg/L | 1 | 9.6 | | | | | | | | | | | | | | | |
| Acidity (to pH 8.3) | Titration | mg $CaCO_3$/L | 0.5 | | | | | | | | | | | 67.5 | <0.5 | <0.5 | 17.5 | 3.3 | 2.4 |
| Alkalinity (to pH 4.5) | Titration | mg $CaCO_3$/L | 0.5 | | | | | | | | | | | 27.0 | 22.0 | 22.0 | 20.0 | 16.7 | 17.1 |
| Dissolved Sulphate (SO4) | Colourimetry | mg/L | 50 | | | | | | | | | | | 3480 | 3500 | 3340 | 3530 | 4070 | 4240 |
| Chloride | IC | mg/L | 0.5 | | | | | | | | | | | 1.4 | 1.1 | 1.0 | 0.8 | 1.0 | 1.1 |
| Fluoride | SIE | mg/L | 0.2 | | | | | | | | | | | 0.60 | 0.40 | <0.2 | <0.2 | 0.30 | 0.34 |
| Bromide | SIE | mg/L | 0.2 | | | | | | | | | | | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Nitrate (as N) | IC | mg/L | 0.05 | | | | | | | | | | | 0.170 | 0.180 | 0.180 | 0.200 | 0.210 | 0.230 |
| Nitrite (as N) | IC | mg/L | 0.05 | | | | | | | | | | | 0.1 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 |
| Ammonia (as N) | Colourimetry | mg/L | 0.01 | | | | | | | | | | | 2.000 | 1.98 | 1.75 | 1.45 | 1.290 | 1.070 |
| ***Dissolved Metals Analysis by ICP-MS:*** | | | | | | | | | | | | | | | | | | | |
| Dissolved Hardness (CaCO3) | ICP-MS | mg/L | 0.5 | | | | | | | | | | | 3210 | 3620 | 3710 | 3850 | 4000 | 4200 |
| Aluminum Dissolved | ICP-MS | mg/L | 0.001 | | | | | | | | | | | <0.001 | 0.001 | <0.001 | <0.001 | <0.001 | 0.002 |
| Antimony Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Arsenic Dissolved | ICP-MS | mg/L | 0.0002 | | | | | | | | | | | 0.0004 | 0.0005 | <0.0002 | <0.0002 | 0.0007 | 0.0011 |
| Barium Dissolved | ICP-MS | mg/L | 0.0002 | | | | | | | | | | | 0.0149 | 0.0125 | 0.0122 | 0.0112 | 0.0105 | 0.0094 |
| Beryllium Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | 0.0002 | 0.0003 |
| Bismuth Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Boron Dissolved | ICP-MS | mg/L | 0.01 | | | | | | | | | | | <0.01 | <0.01 | <0.01 | <0.01 | 0.01 | 0.016 |
| Cadmium Dissolved | ICP-MS | mg/L | 0.00001 | | | | | | | | | | | 0.0238 | 0.0238 | 0.0112 | 0.00741 | 0.00104 | 0.00094 |
| Calcium Dissolved | ICP-MS | mg/L | 0.25 | | | | | | | | | | | 390 | 424 | 430 | 441 | 436 | 456 |
| Chromium Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | 0.0015 | <0.0005 | <0.0005 | <0.0005 | 0.002 | 0.003 |
| Cobalt Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | 0.195 | 0.209 | 0.148 | 0.043 | 0.0023 | 0.0019 |
| Copper Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | 0.0024 | 0.0023 | 0.0014 | 0.0008 | 0.0008 | 0.0009 |
| Iron Dissolved | ICP-MS | mg/L | 0.02 | | | | | | | | | | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Lead Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Lithium Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | 0.0551 | 0.0524 | 0.0531 | 0.0549 | 0.0582 | 0.0613 |
| Magnesium Dissolved | ICP-MS | mg/L | 0.5 | | | | | | | | | | | 544 | 623 | 635 | 667 | 707 | 744 |
| Manganese Dissolved | ICP-MS | mg/L | 0.002 | | | | | | | | | | | 29.4 | 27.3 | 16.7 | 4.58 | 0.005 | 0.013 |
| Mercury Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Molybdenum Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | 0.0002 | 0.0003 | 0.0003 | 0.0002 | 0.0003 | 0.0004 |
| Nickel Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | 0.125 | 0.111 | 0.0845 | 0.0269 | 0.0021 | 0.0019 |
| Phosphorus Dissolved | ICP-MS | mg/L | 0.05 | | | | | | | | | | | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Potassium Dissolved | ICP-MS | mg/L | 0.05 | | | | | | | | | | | 4.68 | 4.78 | 4.6 | 4.49 | 4.85 | 5.11 |
| Selenium Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | 0.0028 | 0.0016 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Silicon Dissolved | ICP-MS | mg/L | 0.05 | | | | | | | | | | | 1.02 | 1.03 | 0.84 | 0.68 | 0.32 | 0.27 |
| Silver Dissolved | ICP-MS | mg/L | 0.00008 | | | | | | | | | | | <0.00008 | <0.00008 | <0.00008 | <0.00008 | <0.00008 | <0.00008 |
| Sodium Dissolved | ICP-MS | mg/L | 0.02 | | | | | | | | | | | 11.4 | 11.5 | 11.8 | 12.1 | 13.2 | 13.6 |
| Strontium Dissolved | ICP-MS | mg/L | 0.0002 | | | | | | | | | | | 1.77 | 1.98 | 1.91 | 1.94 | 1.74 | 1.7 |
| Sulphur Dissolved | ICP-MS | mg/L | 2.5 | | | | | | | | | | | 1030 | 1090 | 1110 | 1190 | 1230 | 1390 |
| Tellurium Dissolved | ICP-MS | mg/L | 0.0002 | | | | | | | | | | | <0.0002 | <0.0002 | <0.0002 | <0.0002 | 0.0003 | 0.0004 |
| Thallium Dissolved | ICP-MS | mg/L | 0.00005 | | | | | | | | | | | 0.00395 | 0.00454 | 0.0044 | 0.00453 | 0.00458 | 0.00466 |
| Thorium Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Tin Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Titanium Dissolved | ICP-MS | mg/L | 0.0005 | | | | | | | | | | | <0.0005 | 0.0006 | 0.0006 | 0.0006 | 0.0008 | 0.0008 |
| Tungsten Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Uranium Dissolved | ICP-MS | mg/L | 0.00005 | | | | | | | | | | | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| Vanadium Dissolved | ICP-MS | mg/L | 0.001 | | | | | | | | | | | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Zinc Dissolved | ICP-MS | mg/L | 0.01 | | | | | | | | | | | 25.6 | 28.5 | 14.8 | 6.28 | 0.322 | 0.277 |
| Zirconium Dissolved | ICP-MS | mg/L | 0.0001 | | | | | | | | | | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| ***Ion Balance:*** | | | | | | | | | | | | | | | | | | | |
| Major Anions | Calc. | meq/L | | | | | | | | | | | | 73.12 | 73.42 | 70.06 | 73.98 | 85.18 | 88.74 |
| Major Cations | Calc. | meq/L | | | | | | | | | | | | 66.74 | 74.96 | 75.45 | 77.93 | 80.67 | 84.73 |
| Difference | Calc. | meq/L | | | | | | | | | | | | -6.38 | 1.54 | 5.38 | 3.95 | -4.51 | -4.01 |
| Balance (%) | Calc. | % | | | | | | | | | | | | -4.6% | 1.0% | 3.7% | 2.6% | -2.7% | -2.3% |

***NOTES:***
**Date of Analysis / COA:**
**Start:** April 27, 2020 / NA
**2 weeks:** May 11, 2020 / 20V600583

## CERTIFICATE OF ANALYSIS ▪ ANOXIC AGING TEST

Global ARD Testing Services Inc.

**GLOBAL PROJECT NO:** 2011
**CLIENT:** SRK Consulting Inc.
**CLIENT PROJECT NAME / NO:** Faro Sludge Aging Test
**REPORT VERSION:** 6

| Parameter | Method | Unit | RDL | Blank (T0) | 1 month | 2 month | 3 month | 4 month | 7 month | Blank (7 month) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Sample ID | | | | | | |
| | | | | Anoxic_DI_pH4 | | | | | | |
| Weight of dry sample used | Weighing Scale | g | 0.01 | | 25 | 25 | 25 | 25 | 25 | |
| Volume of water used | Graduated Cylinder | mL | 0.50 | 475 | 475 | 475 | 475 | 475 | 475 | 475 |
| pH (Undisturbed) | Meter | pH units | 0.01 | 4.1 | 7.6 | 7.7 | 7.9 | 8.1 | 6.9 | 4.5 |
| pH (Stirred) | Meter | pH units | 0.01 | | 8.2 | 8.2 | 8.4 | 8.2 | 7.0 | |
| pH (Filtered) | Meter | pH units | 0.01 | | 8.8 | 8.8 | 7.6 | 8.5 | 7.0 | |
| EC | Meter | µS/cm | 1 | 56 | 3200 | 3410 | 4200 | 4135 | 4070 | 59 |
| ORP | Meter | mV | 1 | 369 | 133 | 137 | 153 | 198 | 163 | 220 |
| Dissolved Oxygen | Meter | mg/L | 1 | 0.1 | 0.2 | 0.5 | 0.5 | 0.4 | 0.3 | 0.0 |
| Acidity (to pH 8.3) | Titration | mg $CaCO_3$/L | 0.5 | | <0.5 | <0.5 | 8.1 | <0.5 | 0.6 | 0.4 |
| Alkalinity (to pH 4.5) | Titration | mg $CaCO_3$/L | 0.5 | | 20.0 | 20.0 | 21.3 | 17.5 | 16.9 | -0.5 |
| Dissolved Sulphate (SO4) | Colourimetry | mg/L | 50 | | 2020 | 2260 | 2410 | 2880 | 2840 | -5 |
| Chloride | IC | mg/L | 0.5 | | 2.40 | 2.00 | 1.6 | 0.6 | 0.9 | -0.5 |
| Fluoride | SIE | mg/L | 0.2 | | 0.20 | <0.2 | <0.2 | <0.2 | <0.2 | -0.20 |
| Bromide | SIE | mg/L | 0.2 | | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | -0.20 |
| Nitrate (as N) | IC | mg/L | 0.05 | | 0.080 | 1.400 | 0.210 | <0.05 | <0.05 | |
| Nitrite (as N) | IC | mg/L | 0.05 | | 0.160 | 0.120 | 0.100 | 0.1 | 0.1 | |
| Ammonia (as N) | Colourimetry | mg/L | 0.01 | | 1.31 | 1.20 | 1.130 | 1.02 | 1.060 | |
| Total Organic Carbon | | mg/L | 5 | | | | | 305 | 290 | |
| Dissolved Organic Carbon | | mg/L | 5 | | | | | 312 | 301 | |
| ***Dissolved Metals Analysis by ICP-MS:*** | | | | | | | | | | |
| Dissolved Hardness (CaCO3) | ICP-MS | mg/L | 0.5 | | 2250.0 | 2440.0 | 2560.0 | 2940 | 2880 | -0.5 |
| Aluminum Dissolved | ICP-MS | mg/L | 0.001 | | <0.001 | <0.001 | <0.001 | 0.002 | 0.004 | -0.001 |
| Antimony Dissolved | ICP-MS | mg/L | 0.0001 | | 0.0002 | 0.0002 | 0.0003 | <0.0001 | <0.0001 | -0.0001 |
| Arsenic Dissolved | ICP-MS | mg/L | 0.0002 | | <0.0002 | <0.0002 | <0.0002 | 0.0007 | 0.0011 | -0.0002 |
| Barium Dissolved | ICP-MS | mg/L | 0.0002 | | 0.0049 | 0.0051 | 0.0064 | 0.0073 | 0.0094 | 0.0003 |
| Beryllium Dissolved | ICP-MS | mg/L | 0.0001 | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | -0.0001 |
| Bismuth Dissolved | ICP-MS | mg/L | 0.0001 | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | -0.0001 |
| Boron Dissolved | ICP-MS | mg/L | 0.01 | | <0.01 | 0.03 | 0.07 | 0.02 | 0.02 | -0.01 |
| Cadmium Dissolved | ICP-MS | mg/L | 0.00001 | | 0.00014 | 0.00015 | 0.00018 | 0.00009 | 0.00006 | -0.00001 |
| Calcium Dissolved | ICP-MS | mg/L | 0.05 | | 289.0 | 321.0 | 384.0 | 449 | 440 | -0.05 |
| Chromium Dissolved | ICP-MS | mg/L | 0.0005 | | <0.0005 | <0.0005 | <0.0005 | 0.0015 | 0.002 | -0.0005 |
| Cobalt Dissolved | ICP-MS | mg/L | 0.0001 | | 0.0004 | 0.0006 | 0.0012 | 0.0006 | 0.0007 | -0.0001 |
| Copper Dissolved | ICP-MS | mg/L | 0.0005 | | 0.0007 | <0.0005 | <0.0005 | 0.0013 | 0.0016 | 0.0006 |
| Iron Dissolved | ICP-MS | mg/L | 0.02 | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | -0.02 |
| Lead Dissolved | ICP-MS | mg/L | 0.0005 | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | -0.0005 |
| Lithium Dissolved | ICP-MS | mg/L | 0.0005 | | 0.0095 | 0.0096 | 0.0099 | 0.0126 | 0.0142 | -0.0005 |
| Magnesium Dissolved | ICP-MS | mg/L | 0.05 | | 372.0 | 380.0 | 390.0 | 442 | 433 | -0.005 |
| Manganese Dissolved | ICP-MS | mg/L | 0.0002 | | 0.007 | 0.0112 | 0.0136 | 0.0013 | 0.0009 | -0.0002 |
| Mercury Dissolved | ICP-MS | mg/L | 0.0005 | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | -0.0005 |
| Molybdenum Dissolved | ICP-MS | mg/L | 0.0001 | | 0.0008 | 0.0004 | 0.0001 | 0.0002 | 0.0002 | -0.0001 |
| Nickel Dissolved | ICP-MS | mg/L | 0.0005 | | 0.0007 | 0.0008 | 0.001 | 0.0011 | 0.002 | -0.0005 |
| Phosphorus Dissolved | ICP-MS | mg/L | 0.05 | | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | -0.05 |
| Potassium Dissolved | ICP-MS | mg/L | 0.05 | | 1.53 | 1.88 | 2.82 | 1.52 | 1.22 | -0.05 |
| Selenium Dissolved | ICP-MS | mg/L | 0.0005 | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | -0.0005 |
| Silicon Dissolved | ICP-MS | mg/L | 0.05 | | 0.5 | 0.5 | 0.52 | 0.61 | 0.69 | -0.05 |
| Silver Dissolved | ICP-MS | mg/L | 0.00008 | | 0.00021 | <0.00008 | <0.00008 | <0.00008 | <0.00008 | -0.00008 |
| Sodium Dissolved | ICP-MS | mg/L | 0.02 | | 6.45 | 5.71 | 4.53 | 7.12 | 7.84 | -0.02 |
| Strontium Dissolved | ICP-MS | mg/L | 0.0002 | | 0.98 | 1.1 | 1.27 | 1.34 | 1.33 | -0.0002 |
| Sulphur Dissolved | ICP-MS | mg/L | 0.5 | | 694.0 | 746.0 | 830.0 | 984 | 972 | -0.5 |
| Tellurium Dissolved | ICP-MS | mg/L | 0.0002 | | 0.0008 | 0.0004 | <0.0002 | <0.0002 | <0.0002 | -0.0002 |
| Thallium Dissolved | ICP-MS | mg/L | 0.00005 | | 0.0034 | 0.0034 | 0.00349 | 0.00405 | 0.00422 | -0.00005 |
| Thorium Dissolved | ICP-MS | mg/L | 0.0001 | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | -0.0001 |
| Tin Dissolved | ICP-MS | mg/L | 0.0005 | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | -0.0005 |
| Titanium Dissolved | ICP-MS | mg/L | 0.0005 | | 0.0013 | 0.0013 | 0.0011 | 0.0007 | 0.0006 | -0.0005 |
| Tungsten Dissolved | ICP-MS | mg/L | 0.0001 | | 0.0002 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | -0.0001 |
| Uranium Dissolved | ICP-MS | mg/L | 0.00005 | | 0.00006 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | -0.00005 |
| Vanadium Dissolved | ICP-MS | mg/L | 0.001 | | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | -0.001 |
| Zinc Dissolved | ICP-MS | mg/L | 0.001 | | 0.073 | 0.166 | 0.264 | 0.043 | 0.034 | -0.001 |
| Zirconium Dissolved | ICP-MS | mg/L | 0.0001 | | 0.0002 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | -0.0001 |
| ***Ion Balance:*** | | | | | | | | | | |
| Major Anions | Calc. | meq/L | | | 42.57 | 47.64 | 50.69 | 60.37 | 59.53 | |
| Major Cations | Calc. | meq/L | | | 45.37 | 47.61 | 51.55 | 59.15 | 57.98 | |
| Difference | Calc. | meq/L | | | 2.80 | -0.03 | 0.86 | -1.22 | -1.55 | |
| Balance (%) | Calc. | % | | | 3.2% | 0.0% | 0.8% | -1.0% | -1.3% | |

***NOTES:***
**Date of Analysis / COA:**
**Start:** April 27, 2020 / NA

## CERTIFICATE OF ANALYSIS ▪ ANOXIC AGING TEST

**Global**
**ARD Testing Services Inc.**

**GLOBAL PROJECT NO:** 2011
**CLIENT:** SRK Consulting Inc.
**CLIENT PROJECT NAME / NO:** Faro Sludge Aging Test
**REPORT VERSION:** 6

| Parameter | Method | Unit | RDL | Blank (T0) | 1 month | 2 month | 3 month | 4 month | 7 month | Blank (6 month) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Sample ID | | | | | | |
| | | | | Anoxic_DI_pH7 | | | | | | |
| Weight of dry sample used | Weighing Scale | g | 0.01 | | 25 | 25 | 25 | 25 | 25 | |
| Volume of water used | Graduated Cylinder | mL | 0.50 | 475 | 475 | 475 | 475 | 475 | 475 | 475 |
| pH (Undisturbed) | Meter | pH units | 0.01 | 7.1 | 7.9 | 8.0 | 7.9 | 7.9 | 7.4 | 6.8 |
| pH (Stirred) | Meter | pH units | 0.01 | | 8.5 | 8.6 | 8.4 | 8.5 | 8.0 | |
| pH (Filtered) | Meter | pH units | 0.01 | | 8.6 | 8.7 | 7.4 | 8.7 | 8.0 | |
| EC | Meter | µS/cm | 1 | 12 | 3220 | 3310 | 4380 | 4040 | 4180 | 42 |
| ORP | Meter | mV | 1 | 206 | 148 | 154 | 147 | 196 | 169 | 193 |
| Dissolved Oxygen | Meter | mg/L | 1 | 0.1 | 0.1 | 0.3 | 0.4 | 0.4 | 0.2 | 0.0 |
| Acidity (to pH 8.3) | Titration | mg $CaCO_3$/L | 0.5 | | <0.5 | <0.5 | 7.5 | <0.5 | 0.5 | 0.6 |
| Alkalinity (to pH 4.5) | Titration | mg $CaCO_3$/L | 0.5 | | 22.0 | 22.0 | 20.0 | 15.0 | 16.1 | 1.1 |
| Dissolved Sulphate (SO4) | Colourimetry | mg/L | 50 | | 2040 | 2230 | 2460 | 2830 | 2910 | -5 |
| Chloride | IC | mg/L | 0.5 | | 0.60 | 1.20 | 1.5 | 0.5 | <0.5 | -0.5 |
| Fluoride | SIE | mg/L | 0.2 | | 0.20 | <0.2 | <0.2 | <0.2 | <0.2 | -0.20 |
| Bromide | SIE | mg/L | 0.2 | | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | -0.50 |
| Nitrate (as N) | IC | mg/L | 0.05 | | <0.05 | <0.05 | 0.440 | <0.05 | <0.05 | |
| Nitrite (as N) | IC | mg/L | 0.05 | | 0.130 | 0.130 | 0.120 | 0.1 | 0.1 | |
| Ammonia (as N) | Colourimetry | mg/L | 0.01 | | 0.99 | 1.00 | 1.090 | 1.050 | 1.020 | |
| Total Organic Carbon | | mg/L | 5 | | | | | 379 | 344 | |
| Dissolved Organic Carbon | | mg/L | 5 | | | | | 391 | 358 | |
| ***Dissolved Metals Analysis by ICP-MS:*** | | | | | | | | | | |
| Dissolved Hardness (CaCO3) | ICP-MS | mg/L | 0.5 | | 2230.0 | 2410.0 | 2680.0 | 2930 | 3030 | -0.5 |
| Aluminum Dissolved | ICP-MS | mg/L | 0.001 | | 0.008 | 0.003 | 0.001 | 0.004 | 0.007 | -0.001 |
| Antimony Dissolved | ICP-MS | mg/L | 0.0001 | | <0.0001 | 0.0001 | 0.0004 | <0.0001 | <0.0001 | -0.0001 |
| Arsenic Dissolved | ICP-MS | mg/L | 0.0002 | | <0.0002 | <0.0002 | <0.0002 | 0.0009 | 0.0012 | -0.0002 |
| Barium Dissolved | ICP-MS | mg/L | 0.0002 | | 0.0058 | 0.0062 | 0.0076 | 0.0088 | 0.0096 | 0.0003 |
| Beryllium Dissolved | ICP-MS | mg/L | 0.0001 | | <0.0001 | <0.0001 | <0.0001 | 0.0002 | 0.0002 | -0.0001 |
| Bismuth Dissolved | ICP-MS | mg/L | 0.0001 | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | -0.0001 |
| Boron Dissolved | ICP-MS | mg/L | 0.01 | | 0.07 | 0.07 | 0.08 | 0.02 | 0.01 | -0.01 |
| Cadmium Dissolved | ICP-MS | mg/L | 0.00001 | | 0.00011 | 0.00017 | 0.00021 | 0.00017 | 0.00013 | -0.00001 |
| Calcium Dissolved | ICP-MS | mg/L | 0.05 | | 290.0 | 344.0 | 370.0 | 427 | 446 | -0.05 |
| Chromium Dissolved | ICP-MS | mg/L | 0.0005 | | <0.0005 | <0.0005 | <0.0005 | 0.0008 | 0.001 | -0.0005 |
| Cobalt Dissolved | ICP-MS | mg/L | 0.0001 | | 0.0004 | 0.0009 | 0.0014 | 0.0005 | 0.0005 | -0.0001 |
| Copper Dissolved | ICP-MS | mg/L | 0.0005 | | 0.0017 | <0.0005 | <0.0005 | 0.0007 | 0.0009 | 0.0005 |
| Iron Dissolved | ICP-MS | mg/L | 0.02 | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | -0.02 |
| Lead Dissolved | ICP-MS | mg/L | 0.0005 | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | -0.0005 |
| Lithium Dissolved | ICP-MS | mg/L | 0.0005 | | 0.0102 | 0.0104 | 0.0108 | 0.0121 | 0.0133 | -0.0005 |
| Magnesium Dissolved | ICP-MS | mg/L | 0.05 | | 366.0 | 387.0 | 427.0 | 452 | 470 | -0.005 |
| Manganese Dissolved | ICP-MS | mg/L | 0.0002 | | 0.0113 | 0.0139 | 0.0184 | 0.003 | 0.005 | -0.0002 |
| Mercury Dissolved | ICP-MS | mg/L | 0.0005 | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | -0.0005 |
| Molybdenum Dissolved | ICP-MS | mg/L | 0.0001 | | 0.0002 | 0.0002 | 0.0002 | 0.0003 | 0.0002 | -0.0001 |
| Nickel Dissolved | ICP-MS | mg/L | 0.0005 | | 0.0009 | 0.0011 | 0.0013 | <0.0005 | <0.0005 | -0.0005 |
| Phosphorus Dissolved | ICP-MS | mg/L | 0.05 | | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | -0.05 |
| Potassium Dissolved | ICP-MS | mg/L | 0.05 | | 1.61 | 2.11 | 2.93 | 1.64 | 1.31 | -0.05 |
| Selenium Dissolved | ICP-MS | mg/L | 0.0005 | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | -0.0005 |
| Silicon Dissolved | ICP-MS | mg/L | 0.05 | | 0.44 | 0.53 | 0.66 | 0.83 | 0.96 | -0.05 |
| Silver Dissolved | ICP-MS | mg/L | 0.00008 | | <0.00008 | <0.00008 | <0.00008 | 0.0001 | 0.00016 | -0.00008 |
| Sodium Dissolved | ICP-MS | mg/L | 0.02 | | 5.59 | 6.12 | 6.71 | 5.4 | 5.1 | 0.03 |
| Strontium Dissolved | ICP-MS | mg/L | 0.0002 | | 0.974 | 1.12 | 1.25 | 1.32 | 1.44 | -0.0002 |
| Sulphur Dissolved | ICP-MS | mg/L | 0.5 | | 693.0 | 744.0 | 872.0 | 925 | 960 | -0.5 |
| Tellurium Dissolved | ICP-MS | mg/L | 0.0002 | | <0.0002 | <0.0002 | <0.0002 | 0.0005 | 0.0003 | -0.0002 |
| Thallium Dissolved | ICP-MS | mg/L | 0.00005 | | 0.00323 | 0.00355 | 0.00373 | 0.00418 | 0.00442 | -0.00005 |
| Thorium Dissolved | ICP-MS | mg/L | 0.0001 | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | -0.0001 |
| Tin Dissolved | ICP-MS | mg/L | 0.0005 | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | -0.0005 |
| Titanium Dissolved | ICP-MS | mg/L | 0.0005 | | 0.0015 | 0.0011 | 0.0009 | 0.0014 | 0.0011 | -0.0005 |
| Tungsten Dissolved | ICP-MS | mg/L | 0.0001 | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | -0.0001 |
| Uranium Dissolved | ICP-MS | mg/L | 0.00005 | | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | -0.00005 |
| Vanadium Dissolved | ICP-MS | mg/L | 0.001 | | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | -0.001 |
| Zinc Dissolved | ICP-MS | mg/L | 0.001 | | 0.099 | 0.155 | 0.352 | 0.058 | 0.044 | -0.001 |
| Zirconium Dissolved | ICP-MS | mg/L | 0.0001 | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | -0.0001 |
| ***Ion Balance:*** | | | | | | | | | | |
| Major Anions | Calc. | meq/L | | | 42.96 | 46.93 | 51.72 | 59.27 | 60.95 | |
| Major Cations | Calc. | meq/L | | | 44.89 | 49.36 | 54.00 | 58.80 | 61.21 | |
| Difference | Calc. | meq/L | | | 1.94 | 2.42 | 2.28 | -0.47 | 0.27 | |
| Balance (%) | Calc. | % | | | 2.2% | 2.5% | 2.2% | -0.4% | 0.2% | |

***NOTES:***
**Date of Analysis / COA:**
**Start:** April 27, 2020 / NA

## CERTIFICATE OF ANALYSIS ▪ ANOXIC AGING TEST

**Global ARD Testing Services Inc.**

**GLOBAL PROJECT NO:** 2011
**CLIENT:** SRK Consulting Inc.
**CLIENT PROJECT NAME / NO:** Faro Sludge Aging Test
**REPORT VERSION:** 6

| Parameter | Method | Unit | RDL | Blank (T0) | 1 month | 2 month | 3 month | 4 month | 7 month | Blank (6 month) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Sample ID | | | | | | |
| | | | | Anoxic_Faro | | | | | | |
| Weight of dry sample used | Weighing Scale | g | 0.01 | | 25 | 25 | 25 | 25 | 25 | |
| Volume of water used | Graduated Cylinder | mL | 0.50 | 475 | 475 | 475 | 475 | 475 | 475 | 475 |
| pH (Undisturbed) | Meter | pH units | 0.01 | 6.8 | 7.8 | 7.9 | 8.0 | 8.0 | 7.0 | 7.2 |
| pH (Stirred) | Meter | pH units | 0.01 | | 8.5 | 8.5 | 8.3 | 8.3 | 7.7 | |
| pH (Filtered) | Meter | pH units | 0.01 | | 8.3 | 8.3 | 7.3 | 8.7 | 7.8 | |
| EC | Meter | µS/cm | 1 | 1904 | 4090 | 4210 | 5170 | 4570 | 4530 | 1840 |
| ORP | Meter | mV | 1 | 215 | 142 | 138 | 143 | 180 | 164 | 109 |
| Dissolved Oxygen | Meter | mg/L | 1 | 0.2 | 0.2 | 0.3 | 0.3 | 0.2 | 0.3 | 0.4 |
| Acidity (to pH 8.3) | Titration | mg $CaCO_3$/L | 0.5 | | <0.5 | <0.5 | 12.5 | <0.5 | 0.5 | 72.0 |
| Alkalinity (to pH 4.5) | Titration | mg $CaCO_3$/L | 0.5 | | 34.5 | 36.0 | 43.8 | 16.7 | 17.3 | 40.0 |
| Dissolved Sulphate (SO4) | Colourimetry | mg/L | 50 | | 2730 | 2900 | 3070 | 3200 | 3270 | 1240 |
| Chloride | IC | mg/L | 0.5 | | 2.30 | 1.80 | 1.6 | 1.7 | 1.6 | 1.2 |
| Fluoride | SIE | mg/L | 0.2 | | 0.40 | <0.2 | <0.2 | 0.20 | 0.20 | 0.50 |
| Bromide | SIE | mg/L | 0.2 | | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | -0.50 |
| Nitrate (as N) | IC | mg/L | 0.05 | | 0.210 | 0.270 | 0.290 | 0.050 | <0.05 | 0.205 |
| Nitrite (as N) | IC | mg/L | 0.05 | | 0.100 | 0.100 | 0.110 | 0.2 | 0.1 | 0.0 |
| Ammonia (as N) | Colourimetry | mg/L | 0.01 | | 1.920 | 1.770 | 1.670 | 1.520 | 1.310 | 1.670 |
| Total Organic Carbon | | mg/L | 5 | | | | | 402 | 374 | |
| Dissolved Organic Carbon | | mg/L | 5 | | | | | 408 | 377 | |
| ***Dissolved Metals Analysis by ICP-MS:*** | | | | | | | | | | |
| Dissolved Hardness (CaCO3) | ICP-MS | mg/L | 0.5 | | 2850.0 | 3180.0 | 3300.0 | 3450 | 3560 | 1030 |
| Aluminum Dissolved | ICP-MS | mg/L | 0.001 | | <0.001 | <0.001 | <0.001 | 0.001 | 0.003 | 0.011 |
| Antimony Dissolved | ICP-MS | mg/L | 0.0001 | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | -0.0001 |
| Arsenic Dissolved | ICP-MS | mg/L | 0.0002 | | <0.0002 | <0.0002 | <0.0002 | 0.0012 | 0.0019 | 0.0002 |
| Barium Dissolved | ICP-MS | mg/L | 0.0002 | | 0.0087 | 0.0091 | 0.0095 | 0.0092 | 0.0122 | 0.0122 |
| Beryllium Dissolved | ICP-MS | mg/L | 0.0001 | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | -0.0001 |
| Bismuth Dissolved | ICP-MS | mg/L | 0.0001 | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | -0.0001 |
| Boron Dissolved | ICP-MS | mg/L | 0.01 | | <0.01 | 0.01 | 0.02 | 0.02 | 0.03 | -0.01 |
| Cadmium Dissolved | ICP-MS | mg/L | 0.00001 | | 0.00039 | 0.00031 | 0.00028 | 0.00018 | 0.00012 | 0.0104 |
| Calcium Dissolved | ICP-MS | mg/L | 0.05 | | 366.0 | 391.0 | 427.0 | 460 | 488 | 231 |
| Chromium Dissolved | ICP-MS | mg/L | 0.0005 | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | -0.0005 |
| Cobalt Dissolved | ICP-MS | mg/L | 0.0001 | | 0.004 | 0.004 | 0.0039 | 0.001 | 0.001 | 0.123 |
| Copper Dissolved | ICP-MS | mg/L | 0.0005 | | 0.0012 | <0.0005 | <0.0005 | 0.0014 | 0.0019 | 0.001 |
| Iron Dissolved | ICP-MS | mg/L | 0.02 | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | 0.28 |
| Lead Dissolved | ICP-MS | mg/L | 0.0005 | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | -0.0005 |
| Lithium Dissolved | ICP-MS | mg/L | 0.0005 | | 0.0668 | 0.0711 | 0.0728 | 0.0815 | 0.093 | 0.0655 |
| Magnesium Dissolved | ICP-MS | mg/L | 0.05 | | 469.0 | 512.0 | 543.0 | 559 | 577 | 107 |
| Manganese Dissolved | ICP-MS | mg/L | 0.0002 | | 1.3 | 0.74 | 0.33 | 0.0035 | 0.0022 | 12.6 |
| Mercury Dissolved | ICP-MS | mg/L | 0.0005 | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | -0.0005 |
| Molybdenum Dissolved | ICP-MS | mg/L | 0.0001 | | 0.0003 | 0.0001 | 0.0001 | 0.0002 | 0.0002 | -0.0001 |
| Nickel Dissolved | ICP-MS | mg/L | 0.0005 | | 0.0046 | 0.0044 | 0.0044 | 0.0011 | 0.0009 | 0.174 |
| Phosphorus Dissolved | ICP-MS | mg/L | 0.05 | | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | -0.05 |
| Potassium Dissolved | ICP-MS | mg/L | 0.05 | | 11.4 | 11.1 | 11 | 10.5 | 9.7 | 9.66 |
| Selenium Dissolved | ICP-MS | mg/L | 0.0005 | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | 0.0024 |
| Silicon Dissolved | ICP-MS | mg/L | 0.05 | | 0.81 | 0.77 | 0.69 | 0.44 | 0.4 | 3.5 |
| Silver Dissolved | ICP-MS | mg/L | 0.00008 | | <0.00008 | <0.00008 | <0.00008 | <0.00008 | <0.00008 | -0.00008 |
| Sodium Dissolved | ICP-MS | mg/L | 0.02 | | 27.6 | 27.4 | 27 | 27 | 26.4 | 23 |
| Strontium Dissolved | ICP-MS | mg/L | 0.0002 | | 1.51 | 1.5 | 1.47 | 1.45 | 1.4 | 0.9 |
| Sulphur Dissolved | ICP-MS | mg/L | 0.5 | | 866.0 | 974.0 | 1090.0 | 1100 | 1070 | 330 |
| Tellurium Dissolved | ICP-MS | mg/L | 0.0002 | | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | -0.0002 |
| Thallium Dissolved | ICP-MS | mg/L | 0.00005 | | 0.00378 | 0.00411 | 0.00441 | 0.00465 | 0.00453 | 0.00059 |
| Thorium Dissolved | ICP-MS | mg/L | 0.0001 | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | -0.0001 |
| Tin Dissolved | ICP-MS | mg/L | 0.0005 | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | -0.0005 |
| Titanium Dissolved | ICP-MS | mg/L | 0.0005 | | 0.0021 | 0.0023 | 0.0023 | 0.0008 | 0.0006 | 0.0006 |
| Tungsten Dissolved | ICP-MS | mg/L | 0.0001 | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | -0.0001 |
| Uranium Dissolved | ICP-MS | mg/L | 0.00005 | | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | 0.00023 |
| Vanadium Dissolved | ICP-MS | mg/L | 0.001 | | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | -0.001 |
| Zinc Dissolved | ICP-MS | mg/L | 0.001 | | 0.157 | 0.166 | 0.191 | 0.073 | 0.055 | 32.1 |
| Zirconium Dissolved | ICP-MS | mg/L | 0.0001 | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | -0.0001 |
| ***Ion Balance:*** | | | | | | | | | | |
| Major Anions | Calc. | meq/L | | | 57.65 | 61.21 | 64.90 | 67.05 | 68.52 | |
| Major Cations | Calc. | meq/L | | | 58.43 | 63.18 | 67.49 | 70.42 | 73.25 | |
| Difference | Calc. | meq/L | | | 0.78 | 1.97 | 2.59 | 3.37 | 4.74 | |
| Balance (%) | Calc. | % | | | 0.7% | 1.6% | 2.0% | 2.5% | 3.3% | |

***NOTES:***
**Date of Analysis / COA:**
**Start:** April 27, 2020 / NA

## CERTIFICATE OF ANALYSIS ▪ ANOXIC AGING TEST

Global ARD Testing Services Inc.

**GLOBAL PROJECT NO:** 2011
**CLIENT:** SRK Consulting Inc.
**CLIENT PROJECT NAME / NO:** Faro Sludge Aging Test
**REPORT VERSION:** 6

| Parameter | Method | Unit | RDL | 10X DL | Blank (T0) | 1 month | 2 month | 3 month | 4 month | 7 month | Blank (7 month) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Sample ID | | | | | | |
| | | | | | Anoxic_Vangorda | | | | | | |
| Weight of dry sample used | Weighing Scale | g | 0.01 | | | 25 | 25 | 25 | 25 | 25 | |
| Volume of water used | Graduated Cylinder | mL | 0.50 | | 475 | 475 | 475 | 475 | 475 | 475 | 475 |
| pH (Undisturbed) | Meter | pH units | 0.01 | 0.10 | 3.5 | 6.8 | 6.8 | 7.6 | 7.9 | 7.4 | 4.2 |
| pH (Stirred) | Meter | pH units | 0.01 | 0.10 | | 6.9 | 7.0 | 7.7 | 8.1 | 7.9 | |
| pH (Filtered) | Meter | pH units | 0.01 | 0.10 | | 7.1 | 7.1 | 7.3 | 8.5 | 7.9 | |
| EC | Meter | µS/cm | 1 | 10.00 | 2790 | 4790 | 4830 | 5550 | 5080 | 5020 | 2760 |
| ORP | Meter | mV | 1 | 10.00 | 328 | 219 | 207 | 213 | 180 | 163 | 204 |
| Dissolved Oxygen | Meter | mg/L | 1 | 5.00 | 0.2 | 0.2 | 0.3 | 0.3 | 0.2 | 0.3 | 0.2 |
| Acidity (to pH 8.3) | Titration | mg $CaCO_3$/L | 0.5 | 5.00 | | 64.0 | 45.0 | 26.9 | <0.5 | 0.5 | 540.0 |
| Alkalinity (to pH 4.5) | Titration | mg $CaCO_3$/L | 0.5 | 5.00 | | 13.0 | 14.0 | 14.4 | 16.7 | 17.4 | -0.5 |
| Dissolved Sulphate (SO4) | Colourimetry | mg/L | 50 | 500.00 | | 3460 | 3370 | 3420 | 3640 | 3810 | 1640 |
| Chloride | IC | mg/L | 0.5 | 5.00 | | 1.40 | 1.00 | 0.9 | 1.8 | 1.6 | 0.5 |
| Fluoride | SIE | mg/L | 0.2 | 2.00 | | 0.40 | 0.20 | 0.20 | 0.30 | 0.30 | 0.45 |
| Bromide | SIE | mg/L | 0.2 | 2.00 | | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | -0.50 |
| Nitrate (as N) | IC | mg/L | 0.05 | 0.50 | | 0.230 | 0.190 | 0.170 | <0.05 | <0.05 | 0.110 |
| Nitrite (as N) | IC | mg/L | 0.05 | 0.50 | | 0.150 | 0.160 | 0.180 | 0.2 | 0.2 | 0.082 |
| Ammonia (as N) | Colourimetry | mg/L | 0.01 | 0.10 | | 1.750 | 1.700 | 1.450 | 1.260 | 1.040 | 0.404 |
| Total Organic Carbon | | mg/L | 5 | 50.00 | | | | | 416 | 388.0 | |
| Dissolved Organic Carbon | | mg/L | 5 | 50.00 | | | | | 435 | 394.000 | |
| ***Dissolved Metals Analysis by ICP-MS:*** | | | | 0.00 | | | | | | | |
| Dissolved Hardness (CaCO3) | ICP-MS | mg/L | 0.5 | 5.00 | | 3670.0 | 3540.0 | 3530.0 | 3950 | 4110 | 1180 |
| Aluminum Dissolved | ICP-MS | mg/L | 0.001 | 0.01 | | <0.001 | <0.001 | <0.001 | <0.001 | 0.003 | 1.5 |
| Antimony Dissolved | ICP-MS | mg/L | 0.0001 | 0.001 | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | -0.0001 |
| Arsenic Dissolved | ICP-MS | mg/L | 0.0002 | 0.002 | | 0.0004 | 0.0002 | 0.0002 | 0.0009 | 0.0011 | 0.0016 |
| Barium Dissolved | ICP-MS | mg/L | 0.0002 | 0.002 | | 0.0116 | 0.012 | 0.012 | 0.01 | 0.01 | 0.0194 |
| Beryllium Dissolved | ICP-MS | mg/L | 0.0001 | 0.001 | | <0.0001 | <0.0001 | <0.0001 | 0.0002 | 0.0003 | 0.0001 |
| Bismuth Dissolved | ICP-MS | mg/L | 0.0001 | 0.001 | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | -0.0001 |
| Boron Dissolved | ICP-MS | mg/L | 0.01 | 0.100 | | 0.02 | 0.02 | 0.01 | 0.03 | 0.03 | -0.01 |
| Cadmium Dissolved | ICP-MS | mg/L | 0.00001 | 0.0001 | | 0.0241 | 0.0241 | 0.0118 | 0.00085 | 0.00077 | 0.0788 |
| Calcium Dissolved | ICP-MS | mg/L | 0.05 | 0.500 | | 429.0 | 410.0 | 416.0 | 461 | 484 | 233 |
| Chromium Dissolved | ICP-MS | mg/L | 0.0005 | 0.005 | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | -0.0005 |
| Cobalt Dissolved | ICP-MS | mg/L | 0.0001 | 0.001 | | 0.221 | 0.117 | 0.0815 | 0.0017 | 0.0013 | 0.59 |
| Copper Dissolved | ICP-MS | mg/L | 0.0005 | 0.005 | | 0.0046 | 0.0025 | 0.0012 | 0.001 | 0.001 | 0.294 |
| Iron Dissolved | ICP-MS | mg/L | 0.02 | 0.200 | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | 110 |
| Lead Dissolved | ICP-MS | mg/L | 0.0005 | 0.01 | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | 0.0734 |
| Lithium Dissolved | ICP-MS | mg/L | 0.0005 | 0.01 | | 0.0523 | 0.0532 | 0.0543 | 0.0578 | 0.0605 | 0.0471 |
| Magnesium Dissolved | ICP-MS | mg/L | 0.05 | 0.50 | | 631.0 | 610.0 | 606.0 | 680 | 702 | 140 |
| Manganese Dissolved | ICP-MS | mg/L | 0.0002 | 0.00 | | 30.5 | 20.1 | 12.5 | 0.0032 | 0.0022 | 47.1 |
| Mercury Dissolved | ICP-MS | mg/L | 0.0005 | 0.01 | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | -0.0005 |
| Molybdenum Dissolved | ICP-MS | mg/L | 0.0001 | 0.001 | | 0.0001 | 0.0001 | <0.0001 | 0.0002 | 0.0002 | 0.0005 |
| Nickel Dissolved | ICP-MS | mg/L | 0.0005 | 0.01 | | 0.106 | 0.076 | 0.0471 | 0.0013 | 0.0009 | 0.45 |
| Phosphorus Dissolved | ICP-MS | mg/L | 0.05 | 0.50 | | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | -0.05 |
| Potassium Dissolved | ICP-MS | mg/L | 0.05 | 0.50 | | 4.66 | 4.23 | 4.41 | 4.33 | 4.47 | 3.27 |
| Selenium Dissolved | ICP-MS | mg/L | 0.0005 | 0.01 | | 0.0011 | 0.0022 | 0.0023 | 0.0006 | <0.0005 | 0.0038 |
| Silicon Dissolved | ICP-MS | mg/L | 0.05 | 0.50 | | 1.14 | 0.87 | 0.62 | 0.34 | 0.28 | 4.6 |
| Silver Dissolved | ICP-MS | mg/L | 0.00008 | 0.00 | | <0.00008 | <0.00008 | <0.00008 | <0.00008 | <0.00008 | -0.00008 |
| Sodium Dissolved | ICP-MS | mg/L | 0.02 | 0.20 | | 11.8 | 11.8 | 11.9 | 13 | 12.4 | 7.55 |
| Strontium Dissolved | ICP-MS | mg/L | 0.0002 | 0.00 | | 1.92 | 1.93 | 1.99 | 1.82 | 1.77 | 1.06 |
| Sulphur Dissolved | ICP-MS | mg/L | 0.5 | 5.00 | | 1140.0 | 1115.0 | 1100.0 | 1230 | 1260 | 535 |
| Tellurium Dissolved | ICP-MS | mg/L | 0.0002 | 0.002 | | <0.0002 | <0.0002 | <0.0002 | 0.0003 | 0.0002 | -0.0002 |
| Thallium Dissolved | ICP-MS | mg/L | 0.00005 | 0.001 | | 0.00542 | 0.00499 | 0.00497 | 0.00511 | 0.00577 | 0.00101 |
| Thorium Dissolved | ICP-MS | mg/L | 0.0001 | 0.001 | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | 0.0001 |
| Tin Dissolved | ICP-MS | mg/L | 0.0005 | 0.01 | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | -0.0005 |
| Titanium Dissolved | ICP-MS | mg/L | 0.0005 | 0.01 | | 0.0018 | 0.0015 | 0.0023 | 0.0009 | 0.0011 | 0.002 |
| Tungsten Dissolved | ICP-MS | mg/L | 0.0001 | 0.00 | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | -0.0001 |
| Uranium Dissolved | ICP-MS | mg/L | 0.00005 | 0.00 | | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | 0.00622 |
| Vanadium Dissolved | ICP-MS | mg/L | 0.001 | 0.01 | | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | -0.001 |
| Zinc Dissolved | ICP-MS | mg/L | 0.001 | 0.01 | | 28.200 | 17.300 | 11.100 | 0.127 | 0.073 | 155 |
| Zirconium Dissolved | ICP-MS | mg/L | 0.0001 | 0.00 | | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | -0.0001 |
| ***Ion Balance:*** | | | | | | | | | | | |
| Major Anions | Calc. | meq/L | | | | 72.40 | 70.53 | 71.57 | 76.23 | 79.78 | 34.20 |
| Major Cations | Calc. | meq/L | | | | 75.99 | 72.58 | 72.09 | 79.67 | 82.60 | 30.09 |
| Difference | Calc. | meq/L | | | | 3.58 | 2.05 | 0.52 | 3.44 | 2.82 | -4.12 |
| Balance (%) | Calc. | % | | | | 2.4% | 1.4% | 0.4% | 2.2% | 1.7% | -6.4% |

***NOTES:***
**Date of Analysis / COA:**
**Start:** April 27, 2020 / NA

# CERTIFICATE OF ANALYSIS ▪ SEQUENTIAL EXTRACTION

Global ARD Testing Services Inc.

**GLOBAL PROJECT NO:** 2011
**CLIENT:** SRK Consulting Inc.
**CLIENT PROJECT NAME / NO:** Faro Sludge Aging Test
**REPORT VERSION:** 7

| | | | | Step-1: Exchangeable | | | Step-2: Water Soluble | |
|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Method** | **Unit** | **RDL** | **1** | **1 (D)** | **CaCl2 Solution** | **1** | **1 (D)** |
| Weight of dry sample used | Weighing Scale | g | 0.01 | 10 | 10 | | Step-1 Res. | Step-1 Res. |
| Reagent | | | | CaCl2 | CaCl2 | | DI Water | DI Water |
| Reagent Concentration | | M | | 1 | 1 | | N/A | N/A |
| Volume Reagent | Graduated Cylinder | mL | 0.50 | 400 | 400 | | 1000 | 1000 |
| Mixing Type | | | | Over-End | Over-End | | Gentle Swirl | Gentle Swirl |
| Mixing Time | | Hours | | 2 | 2 | | 48 | 48 |
| pH | Meter | pH units | 0.01 | 7.3 | 7.4 | | 8.3 | 8.4 |
| EC | Meter | µS/cm | 1 | 133400 | 135500 | | 3120 | 3400 |
| ORP | Meter | mV | 1 | 315 | 326 | | 180 | 163 |
| Acidity (to pH 8.3) | Titration | mg $CaCO_3$/L | 0.5 | 64.0 | 45.0 | | <0.5 | <0.5 |
| Alkalinity (to pH 4.5) | Titration | mg $CaCO_3$/L | 0.5 | 13.0 | 14.0 | | 13.4 | 13.7 |
| Dissolved Sulphate (SO4) | Colourimetry | mg/L | 50 | 2030 | 1960 | <50 | 577 | 658 |
| Chloride | IC | mg/L | 5 | 56900 | 58700 | 58700 | 14.6 | 9.3 |
| Fluoride | SIE | mg/L | 0.2 | 0.37 | 0.31 | <0.2 | 0.30 | 0.33 |
| Nitrate (as N) | IC | mg/L | 0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 |
| Nitrite (as N) | IC | mg/L | 0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 |
| ***Dissolved Metals Analysis by ICP-MS:*** | | | | | | | | |
| Dissolved Hardness (CaCO3) | ICP-MS | mg/L | 0.5 | 91900.0 | 92200.0 | 92200.0 | 572 | 632 |
| Aluminum Dissolved | ICP-MS | mg/L | 0.02/0.001 | <0.02 | 0.03 | 0.07 | <0.001 | <0.001 |
| Antimony Dissolved | ICP-MS | mg/L | 0.002/0.0001 | <0.002 | <0.002 | 0.00 | <0.0001 | <0.0001 |
| Arsenic Dissolved | ICP-MS | mg/L | 0.0002 | 0.012 | 0.012 | 0.014 | <0.0002 | <0.0002 |
| Barium Dissolved | ICP-MS | mg/L | 0.0002 | 1.16 | 1.17 | 1.22 | 0.0078 | 0.0247 |
| Beryllium Dissolved | ICP-MS | mg/L | 0.002/0.0001 | <0.002 | <0.002 | <0.002 | <0.0001 | <0.0001 |
| Bismuth Dissolved | ICP-MS | mg/L | 0.002/0.0001 | <0.002 | <0.002 | <0.002 | <0.0001 | <0.0001 |
| Boron Dissolved | ICP-MS | mg/L | 0.01 | 0.4 | 0.3 | 0.2 | 0.01 | 0.01 |
| Cadmium Dissolved | ICP-MS | mg/L | 0.00001 | 0.0053 | 0.0066 | 0.0003 | 0.00003 | 0.00002 |
| Calcium Dissolved | ICP-MS | mg/L | 0.05 | 36300.0 | 36400.0 | 36900.0 | 208 | 232 |
| Chromium Dissolved | ICP-MS | mg/L | 0.01/0.0005 | <0.010 | <0.010 | <0.010 | <0.0005 | <0.0005 |
| Cobalt Dissolved | ICP-MS | mg/L | 0.0001 | 0.003 | <0.002 | <0.002 | <0.0001 | <0.0001 |
| Copper Dissolved | ICP-MS | mg/L | 0.01/0.0005 | <0.010 | 0.01 | 0.018 | 0.0005 | 0.0007 |
| Iron Dissolved | ICP-MS | mg/L | 1.0/0.02 | <1 | <1 | <1 | 0.01 | 0.01 |
| Lead Dissolved | ICP-MS | mg/L | 0.01/0.0005 | <0.010 | <0.010 | 0.021 | <0.0005 | <0.0005 |
| Lithium Dissolved | ICP-MS | mg/L | 0.0005 | 0.7430 | 0.7030 | 0.7250 | 0.0007 | <0.0005 |
| Magnesium Dissolved | ICP-MS | mg/L | 0.05 | 313.0 | 329.0 | 5.8 | 12.8 | 12.9 |
| Manganese Dissolved | ICP-MS | mg/L | 0.0002 | 0.005 | 0.005 | 0.026 | <0.0002 | 0.0002 |
| Mercury Dissolved | ICP-MS | mg/L | 0.01/0.0005 | <0.010 | <0.010 | <0.010 | <0.0005 | <0.0005 |
| Molybdenum Dissolved | ICP-MS | mg/L | 0.0001 | 0.021 | 0.02 | 0.022 | 0.0006 | 0.0007 |
| Nickel Dissolved | ICP-MS | mg/L | 0.0005 | 0.06 | 0.036 | 0.015 | 0.0013 | <0.0005 |
| Phosphorus Dissolved | ICP-MS | mg/L | 5/0.05 | <5 | <5 | <5 | <0.05 | <0.05 |
| Potassium Dissolved | ICP-MS | mg/L | 0.05 | 726 | 732 | 748 | 0.14 | 0.15 |
| Selenium Dissolved | ICP-MS | mg/L | 0.01/0.0005 | <0.010 | 0.02 | 0.012 | <0.0005 | <0.0005 |
| Silicon Dissolved | ICP-MS | mg/L | 0.05 | 6 | 7 | <5 | <0.05 | <0.05 |
| Silver Dissolved | ICP-MS | mg/L | 0.0016/0.00008 | <0.0016 | <0.0016 | <0.0016 | <0.00008 | <0.00008 |
| Sodium Dissolved | ICP-MS | mg/L | 0.02 | 1330 | 1330 | 1370 | 0.23 | 0.27 |
| Strontium Dissolved | ICP-MS | mg/L | 0.0002 | 24.7 | 24.2 | 25.8 | 0.55 | 0.58 |
| Sulphur Dissolved | ICP-MS | mg/L | 0.5 | 648.0 | 599.0 | 419.0 | 177 | 206 |
| Tellurium Dissolved | ICP-MS | mg/L | 0.004/0.0002 | <0.004 | 0.004 | 0.005 | <0.0002 | <0.0002 |
| Thallium Dissolved | ICP-MS | mg/L | 0.001/0.00005 | 0.0027 | 0.0031 | <0.0010 | 0.00006 | 0.00006 |
| Thorium Dissolved | ICP-MS | mg/L | 0.002/0.0001 | <0.002 | <0.002 | <0.002 | <0.0001 | <0.0001 |
| Tin Dissolved | ICP-MS | mg/L | 0.01/0.0005 | <0.010 | <0.010 | <0.010 | <0.0005 | <0.0005 |
| Titanium Dissolved | ICP-MS | mg/L | 0.01/0.0005 | 0.011 | <0.010 | 0.012 | 0.0008 | <0.0005 |
| Tungsten Dissolved | ICP-MS | mg/L | 0.002/0.0001 | <0.002 | <0.002 | <0.002 | <0.0001 | <0.0001 |
| Uranium Dissolved | ICP-MS | mg/L | 0.001/0.00005 | <0.0010 | <0.0010 | <0.0010 | <0.00005 | <0.00005 |
| Vanadium Dissolved | ICP-MS | mg/L | 0.02/0.001 | <0.02 | <0.02 | <0.02 | <0.001 | <0.001 |
| Zinc Dissolved | ICP-MS | mg/L | 0.001 | 0.450 | 0.460 | 0.040 | 0.015 | 0.02 |
| Zirconium Dissolved | ICP-MS | mg/L | 0.002/0.0001 | <0.002 | <0.002 | <0.002 | <0.0001 | <0.0001 |
| ***Ion Balance:*** | | | | | | | | |
| Major Anions | Calc. | meq/L | | 1645.39 | 1694.65 | 1653.52 | 12.72 | 14.26 |
| Major Cations | Calc. | meq/L | | 1914.12 | 1920.57 | 1921.10 | 11.46 | 12.67 |
| Difference | Calc. | meq/L | | 268.73 | 225.92 | 267.58 | -1.26 | -1.59 |
| Balance (%) | Calc. | % | | 7.5% | 6.2% | 7.5% | -5.2% | -5.9% |

***NOTES:***

**Test was repeated 3 times**

**First:** With 1g of sample which resulted in high RDL due to low volume of water available for analysis

**Second:** With 5g of sample which resulted in very little to no residue after Step-3 to proceed

**Third:** With 10g of sample. Results from this are reported in the table above. Not enough solids were avaialble for QAQC by 4-Acid digesiton.

**Fluroide Analysis:** For Step-3, Fluroide concentration could not be reported due to high acetic acid concentration. The acetate peak masks the Fluoride peak.

## CERTIFICATE OF ANALYSIS ▪ SEQU

Global ARD Testing Services Inc.

| Parameter | Method | Unit | RDL | Step-3: Strongly Reducible | | | | Step-4: Moderately Acid Soluble | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 1 (D) - Cycle 1 | 1 (D) - Cycle 2 | Stock Solution | 1 | 1 (D) | DI Water |
| Weight of dry sample used | Weighing Scale | g | 0.01 | Step-2 Res. | Step-2 Res. | Step-2 Res. | Step-2 Res. | Step-3 Res. | Step-3 Res. | |
| Reagent | | | | NH2OH/HCl in 25% (v/v) HOAc | NH2OH/HCl in 25% (v/v) HOAc | NH2OH/HCl in 25% (v/v) HOAc | NH2OH/HCl in 25% (v/v) HOAc | HCl | HCl | |
| Reagent Concentration | | M | | 0.04 | 0.04 | 0.04 | 0.04 | | | |
| Volume Reagent | Graduated Cylinder | mL | 0.50 | 400 | 400 | 400 | 400 | 1000 | 1000 | |
| Mixing Type | | | | Vortex @ 90˚C | Vortex @ 90˚C | Vortex @ 90˚C | Vortex @ 90˚C | | | 4.2 |
| Mixing Time | | Hours | | 2 | 2 | 2 | 2 | | | |
| pH | Meter | pH units | 0.01 | 3.4 | 3.4 | 2.4 | | | | 5 |
| EC | Meter | µS/cm | 1 | 12020 | 11970 | 4470 | | | | 1 |
| ORP | Meter | mV | 1 | 235 | 236 | 233 | | | | 5 |
| Acidity (to pH 8.3) | Titration | mg $CaCO_3$/L | 0.5 | 194773 | 193636 | 222368 | | | | 1.0 |
| Alkalinity (to pH 4.5) | Titration | mg $CaCO_3$/L | 0.5 | <0.5 | <0.5 | <0.5 | | | | <0.5 |
| Dissolved Sulphate (SO4) | Colourimetry | mg/L | 50 | 1310 | 1170 | 170 | <50 | | | 1640 |
| Chloride | IC | mg/L | 5 | 1290 | 1300 | 1510 | 1540 | | | |
| Fluoride | SIE | mg/L | 0.2 | | | | | | | |
| Nitrate (as N) | IC | mg/L | 0.005 | 53 | 46 | 281 | 282 | | | |
| Nitrite (as N) | IC | mg/L | 0.005 | 48 | 53 | 203 | 218 | | | |
| ***Dissolved Metals Analysis by ICP-MS:*** | | | | | | | | | | |
| Dissolved Hardness (CaCO3) | ICP-MS | mg/L | 0.5 | 8750 | 8650 | 73.3 | <0.5 | | | <0.5 |
| Aluminum Dissolved | ICP-MS | mg/L | 0.02/0.001 | 7.36 | 6.67 | 0.32 | <0.01 | | | <0.001 |
| Antimony Dissolved | ICP-MS | mg/L | 0.002/0.0001 | 0.006 | 0.006 | <0.001 | <0.001 | | | <0.0001 |
| Arsenic Dissolved | ICP-MS | mg/L | 0.0002 | 0.041 | 0.043 | 0.02 | 0.004 | | | <0.0002 |
| Barium Dissolved | ICP-MS | mg/L | 0.0002 | 0.067 | 0.067 | 0.091 | <0.002 | | | <0.0002 |
| Beryllium Dissolved | ICP-MS | mg/L | 0.002/0.0001 | 0.004 | 0.004 | <0.001 | <0.001 | | | <0.0001 |
| Bismuth Dissolved | ICP-MS | mg/L | 0.002/0.0001 | <0.001 | <0.001 | <0.001 | <0.001 | | | <0.0001 |
| Boron Dissolved | ICP-MS | mg/L | 0.01 | 0.2 | <0.1 | <0.1 | <0.1 | | | <0.01 |
| Cadmium Dissolved | ICP-MS | mg/L | 0.00001 | 0.572 | 0.628 | 0.0036 | <0.0001 | | | <0.00001 |
| Calcium Dissolved | ICP-MS | mg/L | 0.05 | 1460 | 1420 | 16.8 | <0.5 | | | <0.05 |
| Chromium Dissolved | ICP-MS | mg/L | 0.01/0.0005 | 0.012 | 0.013 | 0.008 | 0.009 | | | <0.0005 |
| Cobalt Dissolved | ICP-MS | mg/L | 0.0001 | 5.29 | 5.5 | 0.033 | <0.001 | | | <0.0001 |
| Copper Dissolved | ICP-MS | mg/L | 0.01/0.0005 | 0.158 | 0.148 | 0.006 | <0.005 | | | <0.0005 |
| Iron Dissolved | ICP-MS | mg/L | 1.0/0.02 | 1260 | 1280 | 15.3 | 0.2 | | | <0.02 |
| Lead Dissolved | ICP-MS | mg/L | 0.01/0.0005 | 0.09 | 0.079 | 0.008 | <0.005 | | | <0.0005 |
| Lithium Dissolved | ICP-MS | mg/L | 0.0005 | 0.018 | 0.016 | 0.02 | 0.011 | | | <0.0005 |
| Magnesium Dissolved | ICP-MS | mg/L | 0.05 | 1240 | 1240 | 7.61 | <0.05 | | | <0.005 |
| Manganese Dissolved | ICP-MS | mg/L | 0.0002 | 418 | 459 | 2.35 | 0.005 | | | <0.0002 |
| Mercury Dissolved | ICP-MS | mg/L | 0.01/0.0005 | <0.005 | <0.005 | <0.005 | <0.005 | | | <0.0005 |
| Molybdenum Dissolved | ICP-MS | mg/L | 0.0001 | 0.003 | 0.002 | 0.001 | <0.001 | | | <0.0001 |
| Nickel Dissolved | ICP-MS | mg/L | 0.0005 | 6.85 | 7.31 | 0.015 | <0.005 | | | <0.0005 |
| Phosphorus Dissolved | ICP-MS | mg/L | 5/0.05 | 4.6 | 5.9 | <0.5 | <0.5 | | | <0.05 |
| Potassium Dissolved | ICP-MS | mg/L | 0.05 | <0.5 | <0.5 | <0.5 | <0.5 | | | <0.05 |
| Selenium Dissolved | ICP-MS | mg/L | 0.01/0.0005 | 0.043 | 0.056 | <0.005 | <0.005 | | | <0.0005 |
| Silicon Dissolved | ICP-MS | mg/L | 0.05 | 106 | 106 | 4.1 | 3.3 | | | <0.05 |
| Silver Dissolved | ICP-MS | mg/L | 0.0016/0.00008 | <0.0008 | <0.0008 | <0.0008 | <0.0008 | | | <0.00008 |
| Sodium Dissolved | ICP-MS | mg/L | 0.02 | 1.1 | 1 | 0.6 | 0.4 | | | <0.02 |
| Strontium Dissolved | ICP-MS | mg/L | 0.0002 | 3.86 | 3.35 | 0.113 | <0.002 | | | <0.0002 |
| Sulphur Dissolved | ICP-MS | mg/L | 0.5 | 410 | 382 | <5 | <5 | | | <0.5 |
| Tellurium Dissolved | ICP-MS | mg/L | 0.004/0.0002 | <0.002 | 0.002 | <0.002 | <0.002 | | | <0.0002 |
| Thallium Dissolved | ICP-MS | mg/L | 0.001/0.00005 | 0.0017 | 0.0015 | <0.0005 | <0.0005 | | | <0.00005 |
| Thorium Dissolved | ICP-MS | mg/L | 0.002/0.0001 | <0.001 | <0.001 | <0.001 | <0.001 | | | <0.0001 |
| Tin Dissolved | ICP-MS | mg/L | 0.01/0.0005 | <0.005 | <0.005 | <0.005 | <0.005 | | | <0.0005 |
| Titanium Dissolved | ICP-MS | mg/L | 0.01/0.0005 | 0.162 | 0.167 | 0.073 | 0.029 | | | <0.0005 |
| Tungsten Dissolved | ICP-MS | mg/L | 0.002/0.0001 | <0.001 | <0.001 | <0.001 | <0.001 | | | <0.0001 |
| Uranium Dissolved | ICP-MS | mg/L | 0.001/0.00005 | 0.0526 | 0.0477 | 0.001 | 0.0009 | | | <0.00005 |
| Vanadium Dissolved | ICP-MS | mg/L | 0.02/0.001 | 0.54 | 0.56 | <0.01 | <0.01 | | | <0.001 |
| Zinc Dissolved | ICP-MS | mg/L | 0.001 | 3150 | 3380 | 18.8 | 0.08 | | | <0.001 |
| Zirconium Dissolved | ICP-MS | mg/L | 0.002/0.0001 | 0.006 | 0.005 | <0.001 | <0.001 | | | <0.0001 |
| ***Ion Balance:*** | | | | | | | | | | |
| Major Anions | Calc. | meq/L | | 63.63 | 60.99 | 46.08 | | | | |
| Major Cations | Calc. | meq/L | | 333.17 | 340.31 | 2.74 | | | | |
| Difference | Calc. | meq/L | | 269.54 | 279.31 | -43.33 | | | | |
| Balance (%) | Calc. | % | | 67.9% | 69.6% | -88.8% | | | | |

***NOTES:***

**Test was repeated 3 times**

**First:** With 1g of sample which resulted in high RDL due to low volume of water available for ar

**Second:** With 5g of sample which resulted in very little to no residue after Step-3 to proceed

**Third:** With 10g of sample. Results from this are reported in the table above. Not enough solids

**Fluroide Analysis:** For Step-3, Fluroide concentration could not be reported due to high acetic aci

# Appendix D: Particle Size Analysis Laboratory Report

**Sample Name:** Faro Sludge Sample 2011 - Average
**SOP Name:**
**Measured:** Wednesday, January 06, 2021 4:26:51 PM

**Sample Source & type:** Supplier
**Measured by:** erin
**Analysed:** Wednesday, January 06, 2021 4:26:52 PM

**Sample bulk lot ref:**
**Result Source:** Averaged

---

**Particle Name:** Pyrite
**Accessory Name:** Hydro 2000MU (A)
**Analysis model:** General purpose
**Sensitivity:** Normal

**Particle RI:** 1.810
**Absorption:** 0
**Size range:** 0.020 to 2000.000 um
**Obscuration:** 16.76 %

**Dispersant Name:** Water
**Dispersant RI:** 1.330
**Weighted Residual:** 0.642 %
**Result Emulation:** Off

---

**Concentration:** 0.0453 %Vol
**Span :** 3.368
**Uniformity:** 1.13
**Result units:** Volume

**Specific Surface Area:** 0.155 m²/g
**Surface Weighted Mean D[3,2]:** 19.342 um
**Vol. Weighted Mean D[4,3]:** 58.223 um
**Density:** 2.000 g/cm³

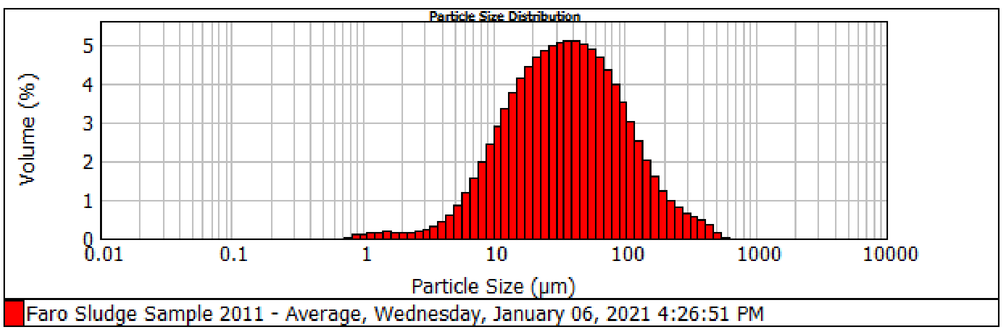
**d(0.1): 9.524 um** **d(0.5): 35.563 um** **d(0.9): 129.289 um**

---

| Mesh No | Aperture µm | Volume In % | Vol Below % |
|---|---|---|---|
| 10 | 2000 | 0.00 | 100.00 |
| 12 | 1700 | 0.00 | 100.00 |
| 14 | 1400 | 0.00 | 100.00 |
| 16 | 1180 | 0.00 | 100.00 |
| 18 | 1000 | 0.00 | 100.00 |
| 20 | 850 | 0.00 | 100.00 |
| 25 | 710 | 0.00 | 100.00 |
| 30 | 600 | 0.11 | 100.00 |
| 35 | 500 | | 99.89 |

| Mesh No | Aperture µm | Volume In % | Vol Below % |
|---|---|---|---|
| 35 | 500 | 0.39 | 99.89 |
| 40 | 425 | 0.61 | 99.51 |
| 45 | 355 | 0.72 | 98.90 |
| 50 | 300 | 0.96 | 98.18 |
| 60 | 250 | 1.12 | 97.22 |
| 70 | 212 | 1.47 | 96.10 |
| 80 | 180 | 2.23 | 94.62 |
| 100 | 150 | 3.01 | 92.39 |
| 120 | 125 | | 89.38 |

| Mesh No | Aperture µm | Volume In % | Vol Below % |
|---|---|---|---|
| 120 | 125 | 3.48 | 89.38 |
| 140 | 106 | 4.15 | 85.90 |
| 170 | 90 | 5.37 | 81.75 |
| 200 | 75 | 5.71 | 76.38 |
| 230 | 63 | 6.05 | 70.66 |
| 270 | 53 | 5.94 | 64.61 |
| 325 | 45 | 6.23 | 58.67 |
| 400 | 38 | | 52.44 |




**Operator notes:** *Pump Speed 1200 RPM*

**Sample Name:**
Faro Sludge Sample 2011-duplicate -

**SOP Name:**

**Measured:**
Thursday, January 07, 2021 12:59:50 PM

**Sample Source & type:**
Supplier

**Measured by:**
erin

**Analysed:**
Thursday, January 07, 2021 12:59:51 PM

**Sample bulk lot ref:**

**Result Source:**
Averaged

---

**Particle Name:**
Pyrite

**Accessory Name:**
Hydro 2000MU (A)

**Analysis model:**
General purpose

**Sensitivity:**
Normal

**Particle RI:**
1.810

**Absorption:**
0

**Size range:**
0.020 to 2000.000 um

**Obscuration:**
12.58 %

**Dispersant Name:**
Water

**Dispersant RI:**
1.330

**Weighted Residual:**
0.348 %

**Result Emulation:**
Off

---

**Concentration:**
0.0336 %Vol

**Span :**
3.133

**Uniformity:**
1.04

**Result units:**
Volume

**Specific Surface Area:**
0.153 m²/g

**Surface Weighted Mean D[3,2]:**
19.577 um

**Vol. Weighted Mean D[4,3]:**
57.292 um

**Density:**
2.000 g/cm³

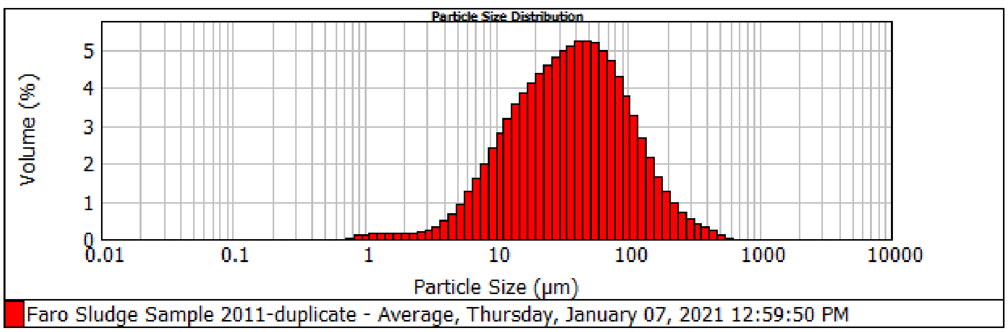
**d(0.1):** 9.384 um **d(0.5):** 37.264 um **d(0.9):** 126.128 um

---

| Mesh No | Aperture µm | Volume In % | Vol Below % |
|---|---|---|---|
| 10 | 2000 | 0.00 | 100.00 |
| 12 | 1700 | 0.00 | 100.00 |
| 14 | 1400 | 0.00 | 100.00 |
| 16 | 1180 | 0.00 | 100.00 |
| 18 | 1000 | 0.00 | 100.00 |
| 20 | 850 | 0.00 | 100.00 |
| 25 | 710 | 0.00 | 100.00 |
| 30 | 600 | 0.08 | 100.00 |
| 35 | 500 | | 99.92 |

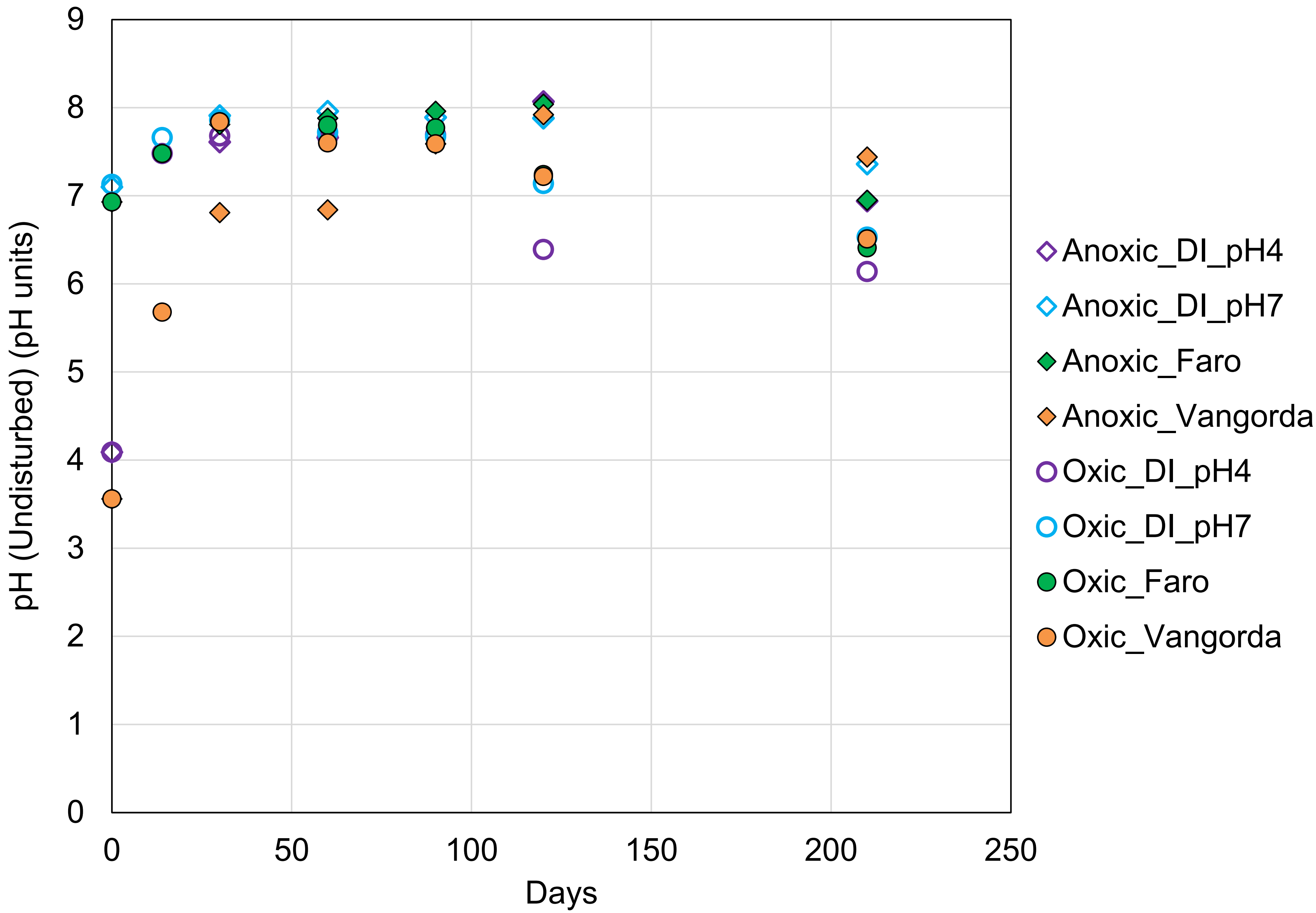
| Mesh No | Aperture µm | Volume In % | Vol Below % |
|---|---|---|---|
| 35 | 500 | 0.25 | 99.92 |
| 40 | 425 | 0.41 | 99.66 |
| 45 | 355 | 0.54 | 99.25 |
| 50 | 300 | 0.82 | 98.71 |
| 60 | 250 | 1.05 | 97.89 |
| 70 | 212 | 1.48 | 96.84 |
| 80 | 180 | 2.33 | 95.36 |
| 100 | 150 | 3.21 | 93.03 |
| 120 | 125 | | 89.82 |

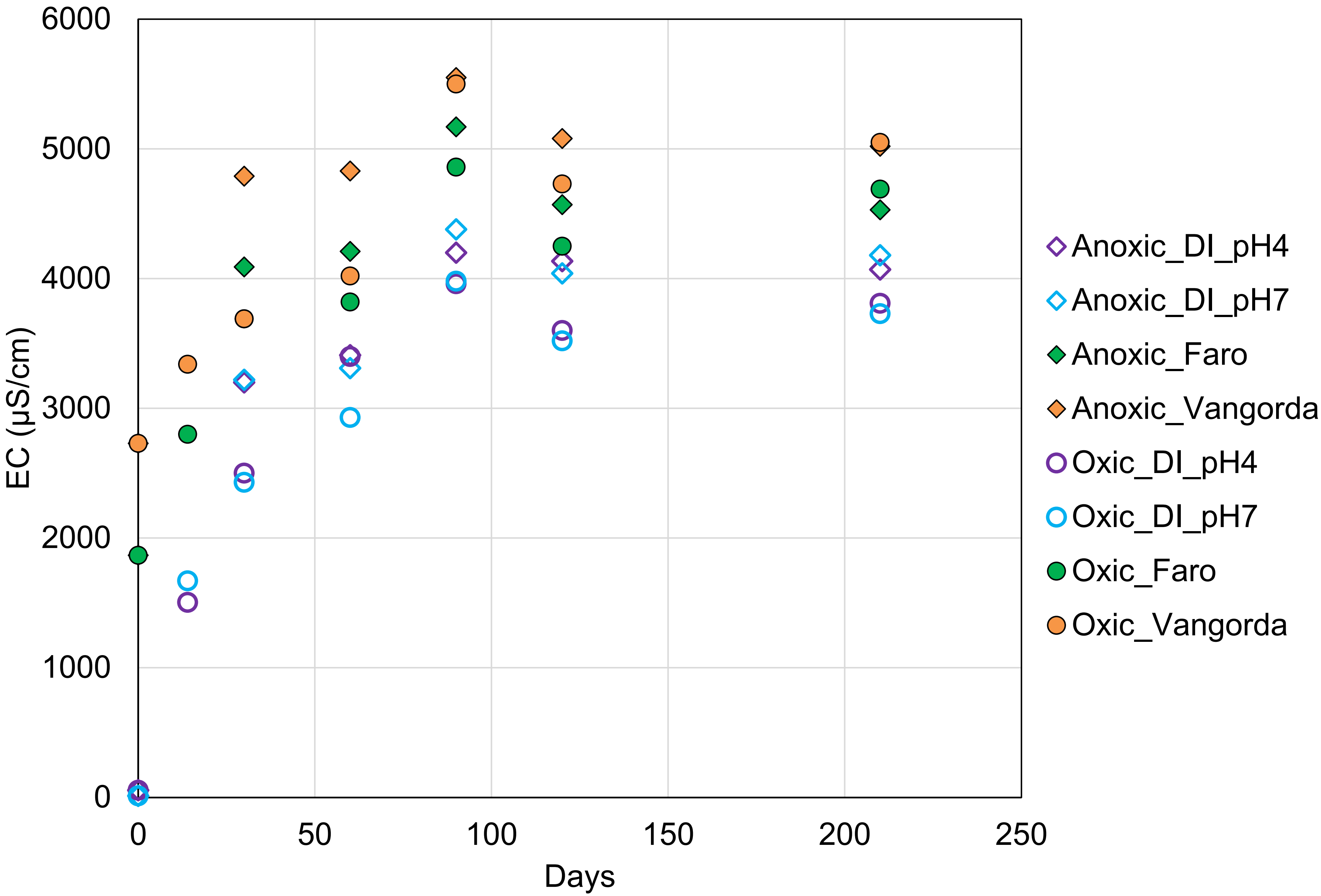
| Mesh No | Aperture µm | Volume In % | Vol Below % |
|---|---|---|---|
| 120 | 125 | 3.74 | 89.82 |
| 140 | 106 | 4.48 | 86.08 |
| 170 | 90 | 5.79 | 81.60 |
| 200 | 75 | 6.13 | 75.80 |
| 230 | 63 | 6.42 | 69.67 |
| 270 | 53 | 6.19 | 63.25 |
| 325 | 45 | 6.34 | 57.06 |
| 400 | 38 | | 50.72 |

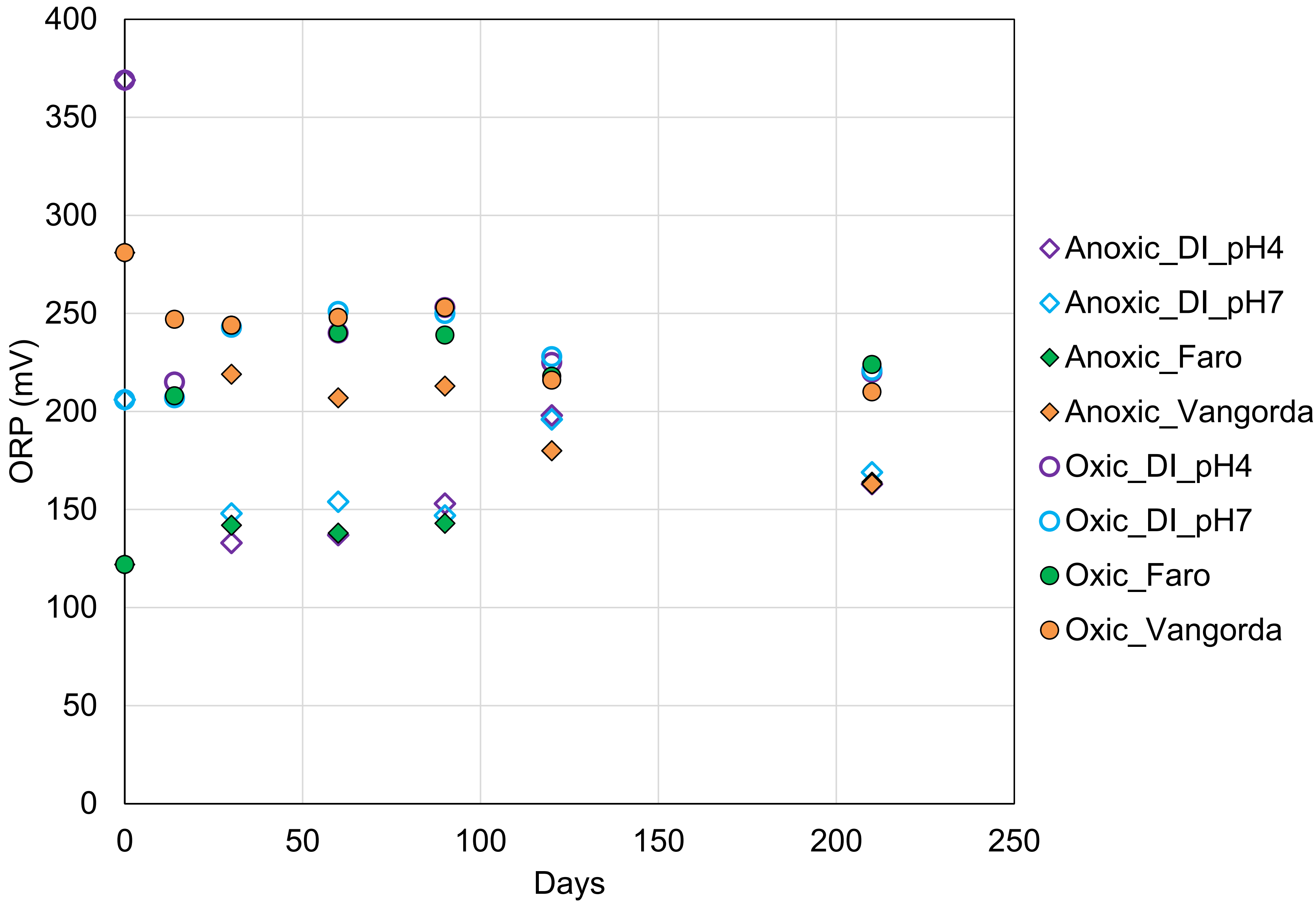


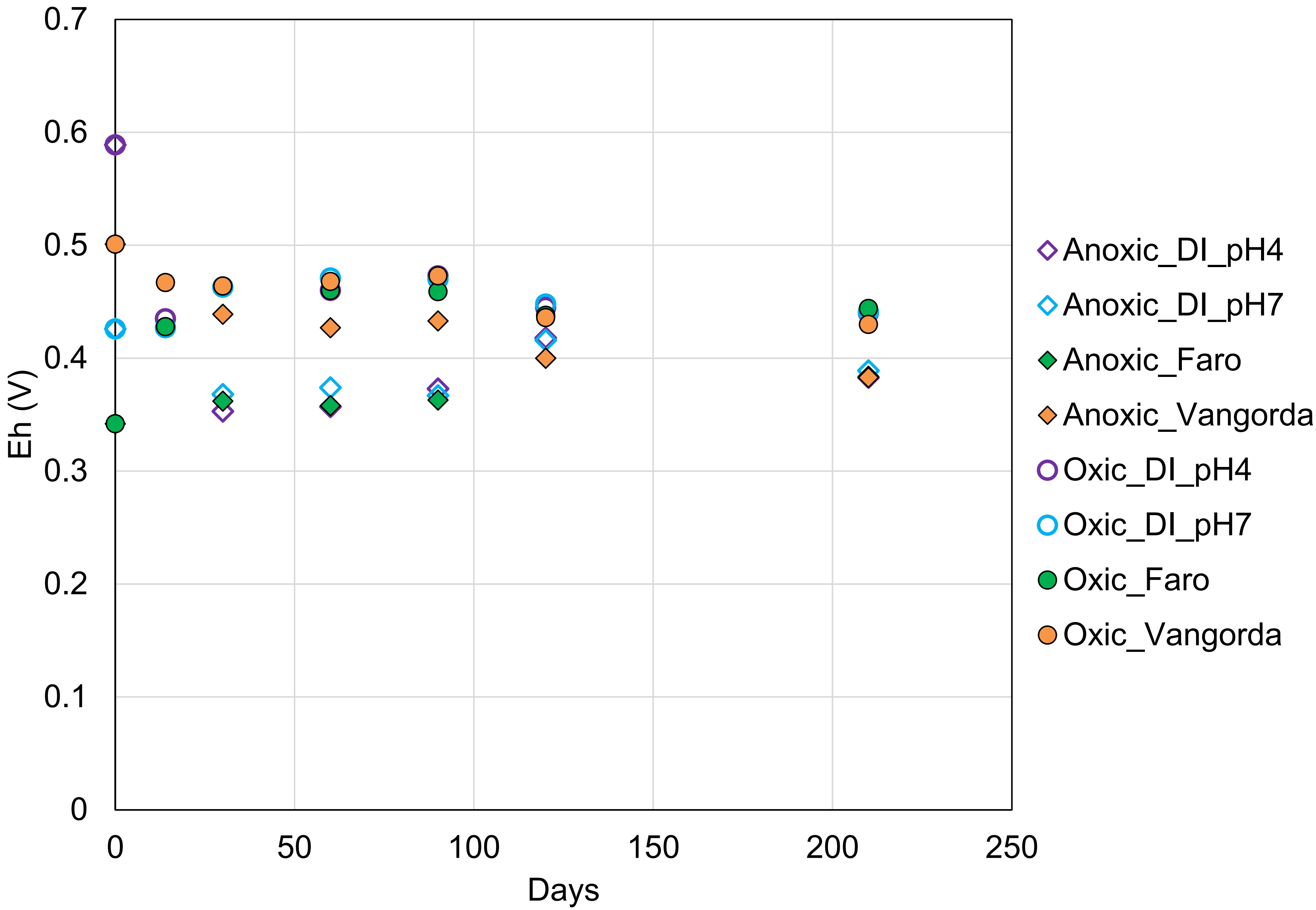

**Operator notes:** *Pump Speed 1200 RPM*

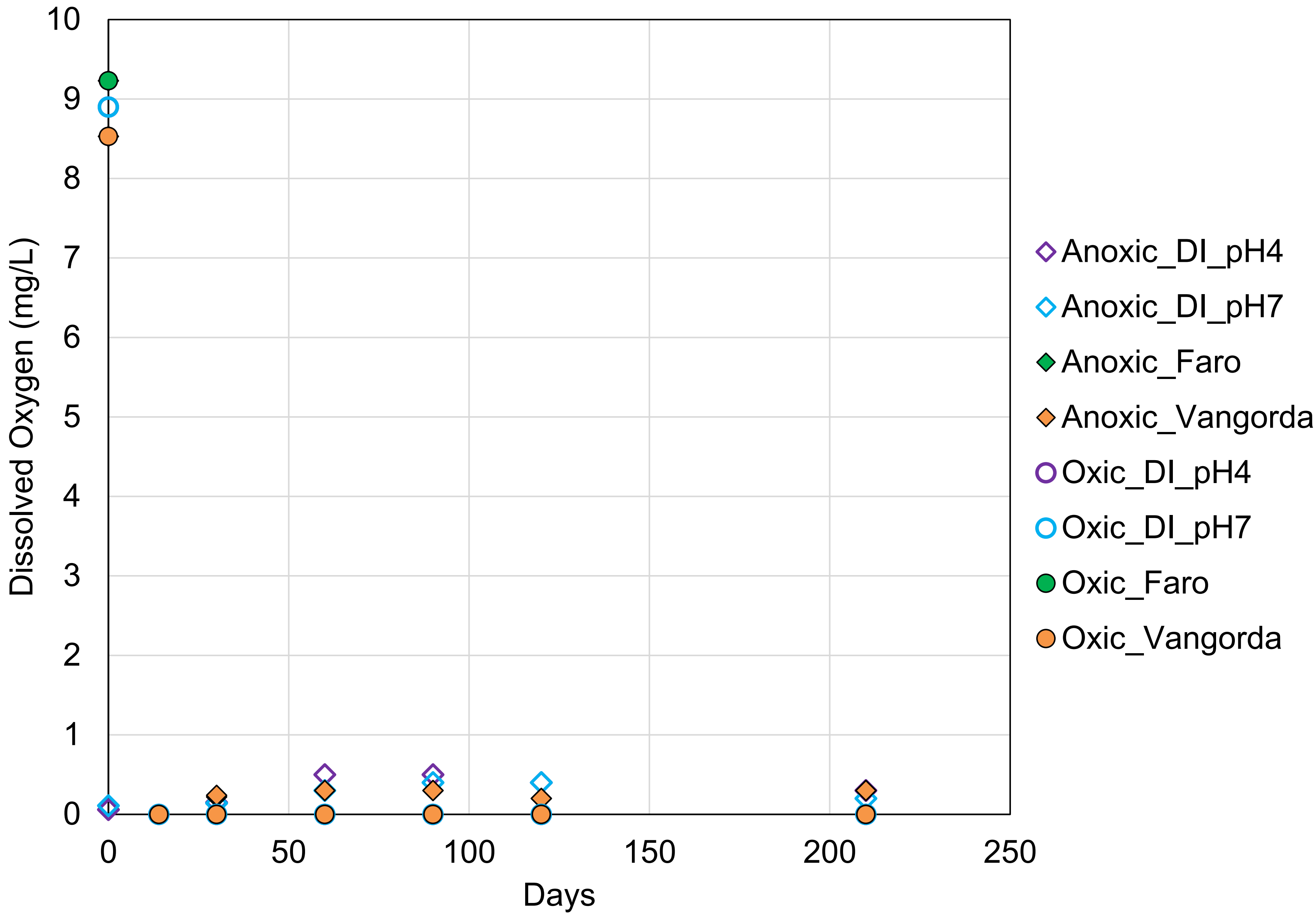
# Appendix E: Aging Test Time Series Charts

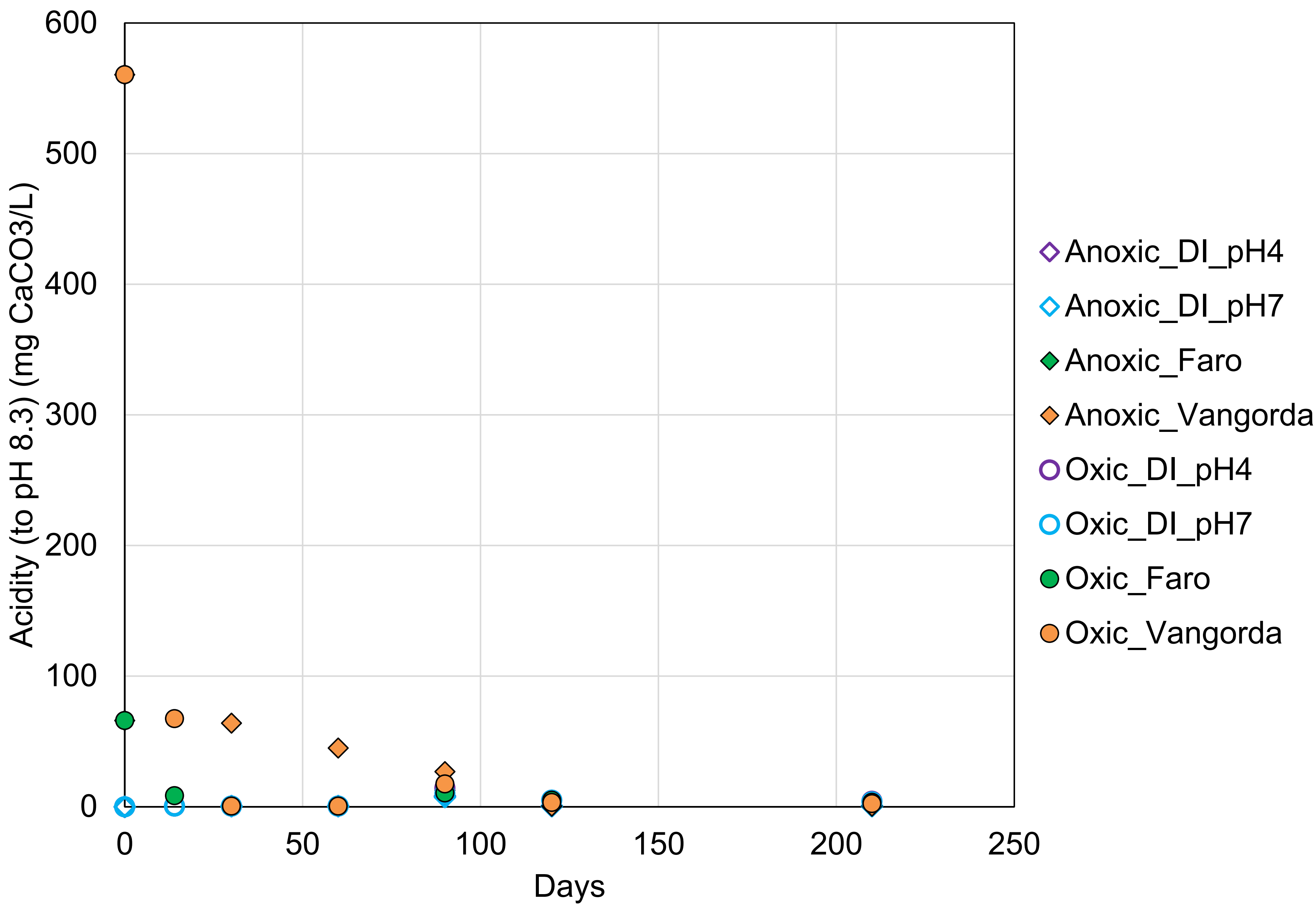

pH (Undisturbed) (pH units)
9
8
7
6
5
4
3
2
1
0
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

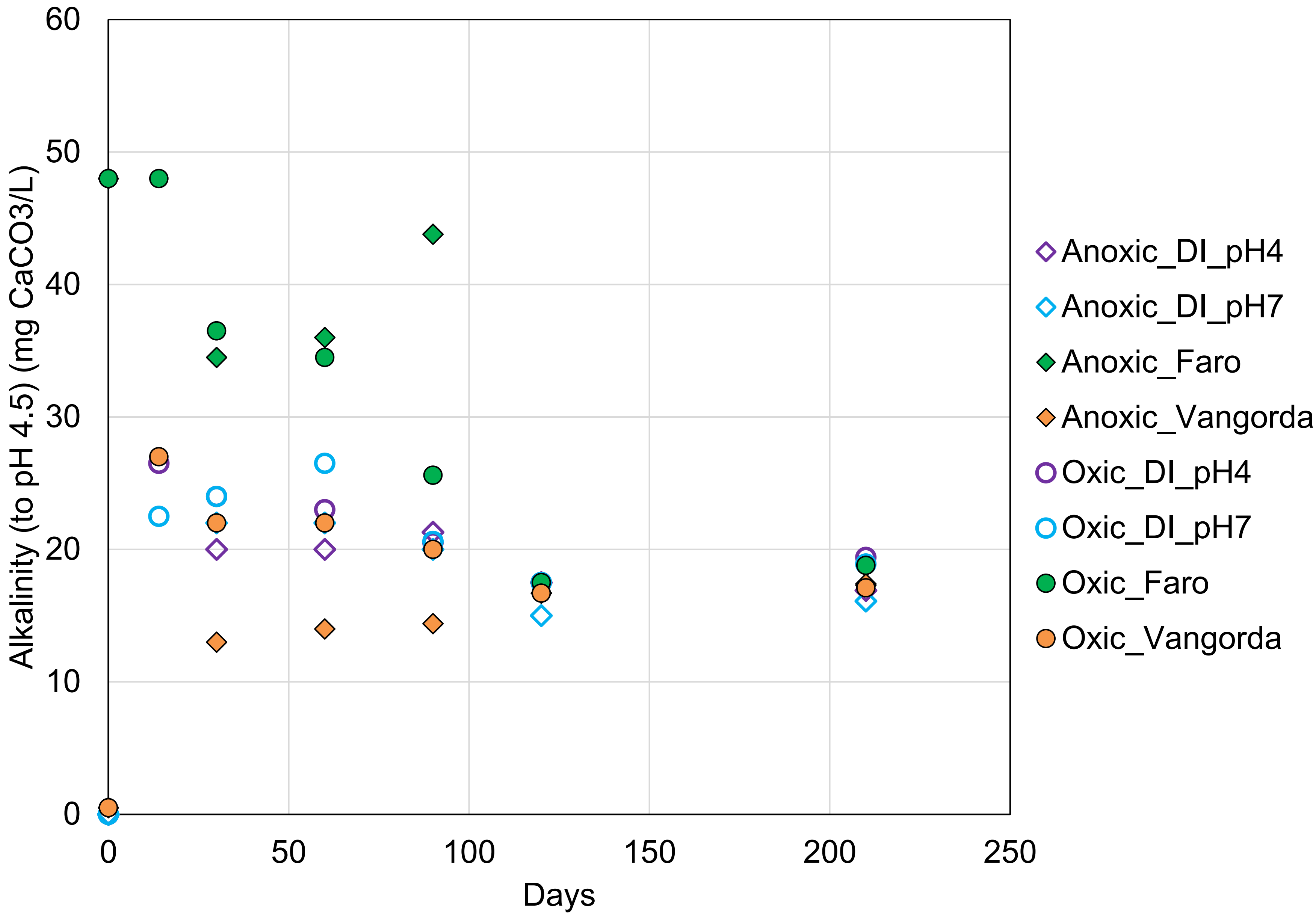

6000
5000
4000
3000
2000
1000
0
EC (µS/cm)
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

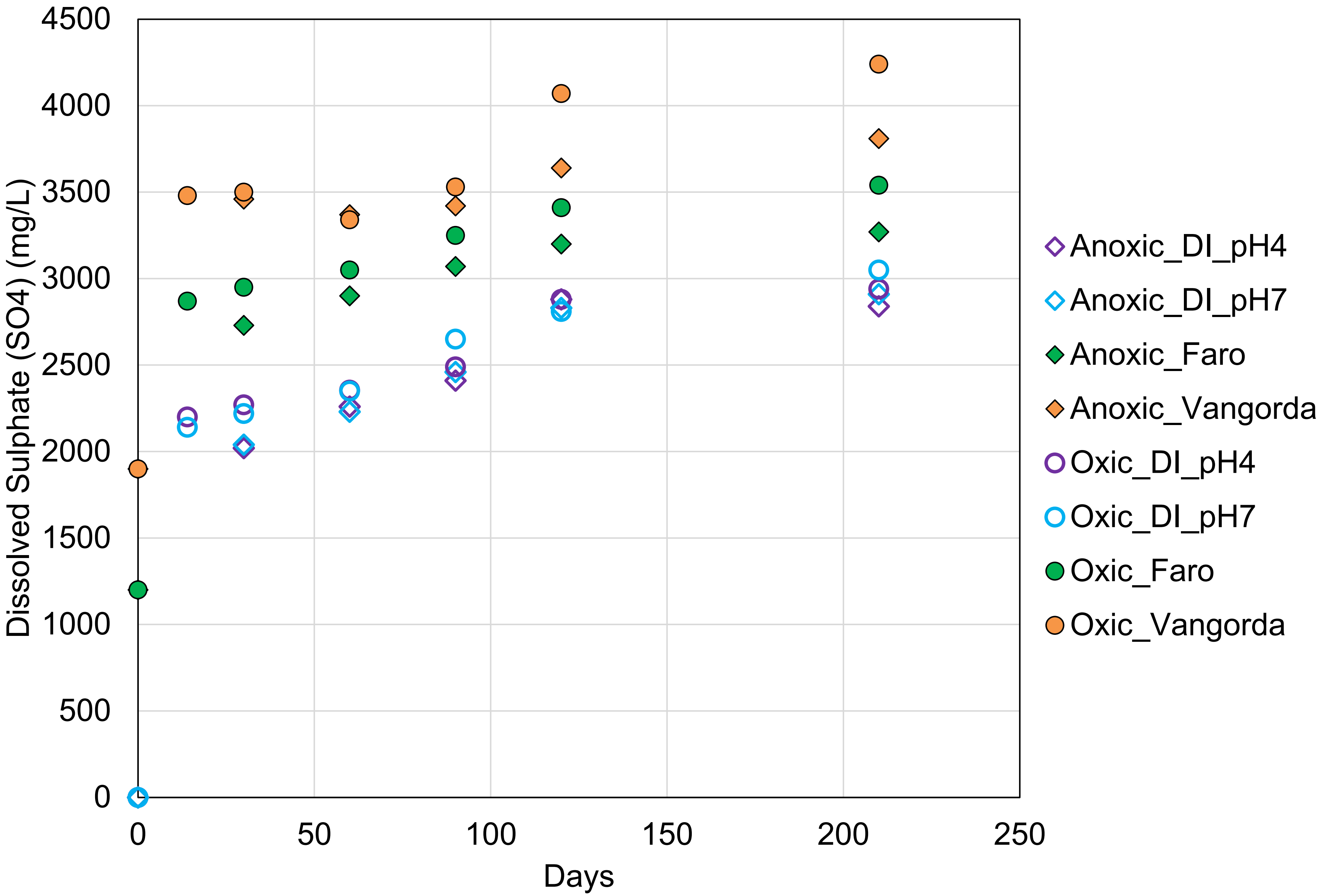

400
350
300
250
200
150
100
50
0
ORP (mV)
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

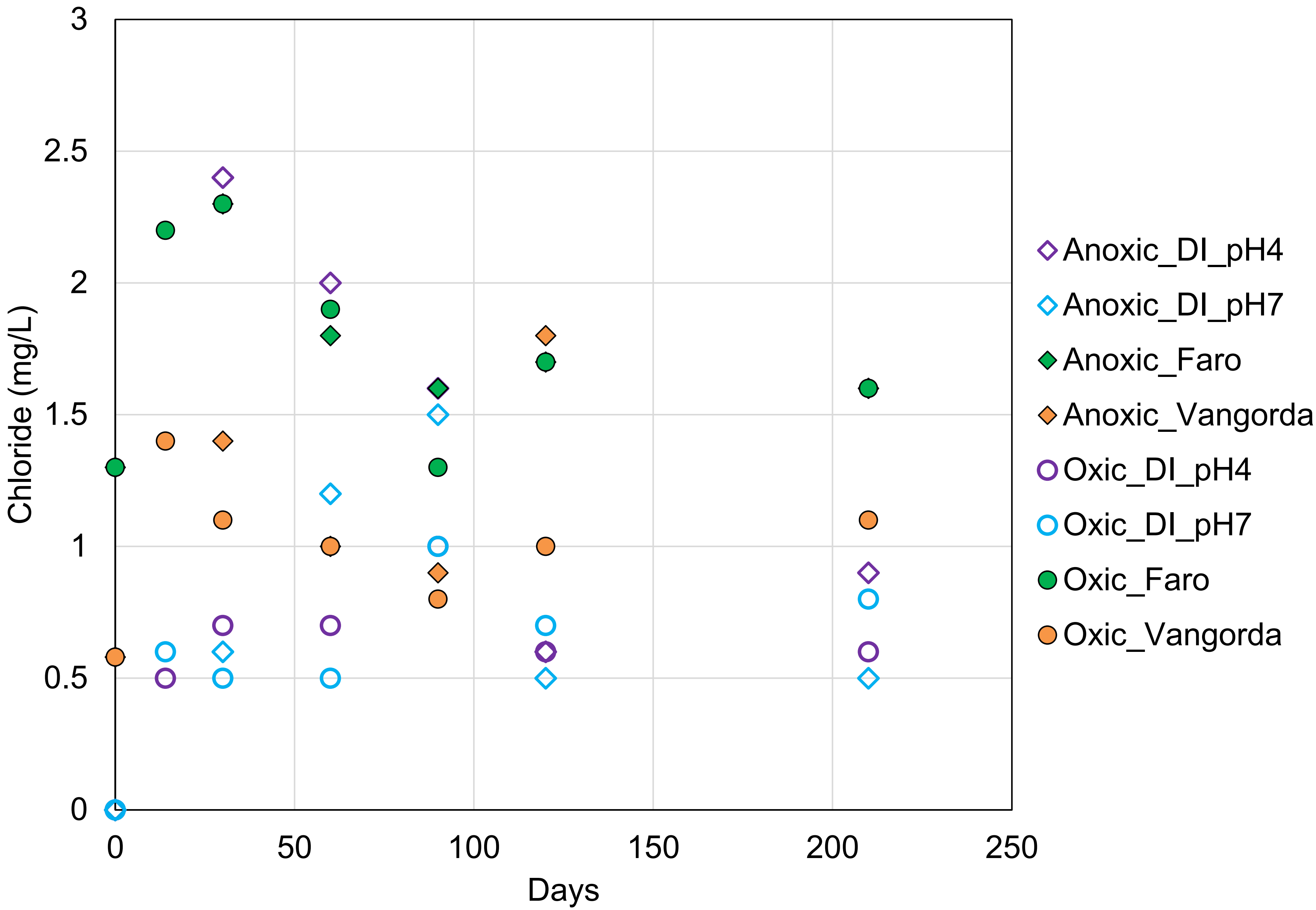

Eh (V)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

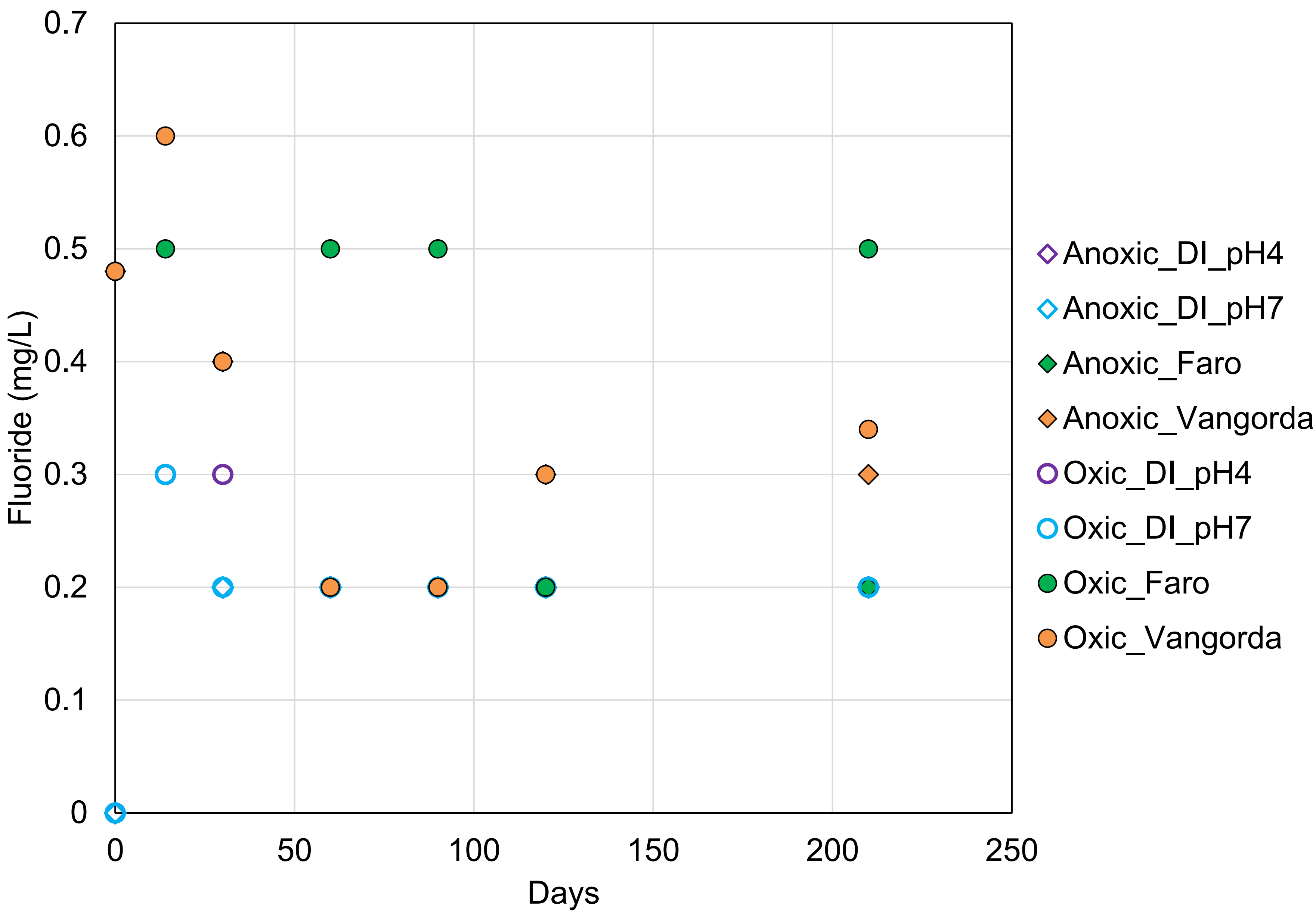

Dissolved Oxygen (mg/L)
10
9
8
7
6
5
4
3
2
1
0
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

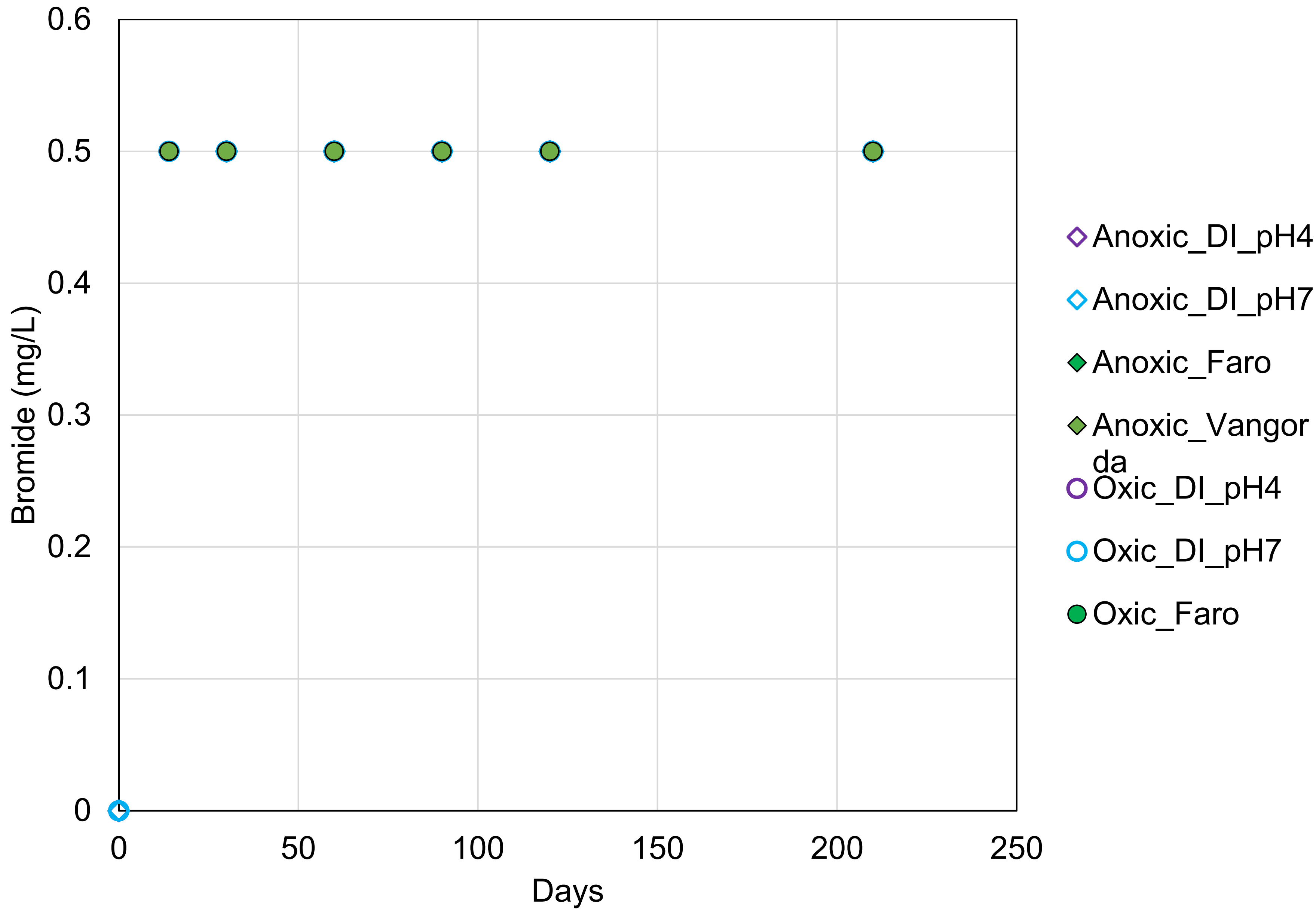

600
500
400
300
200
100
0
Acidity (to pH 8.3) (mg CaCO3/L)
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

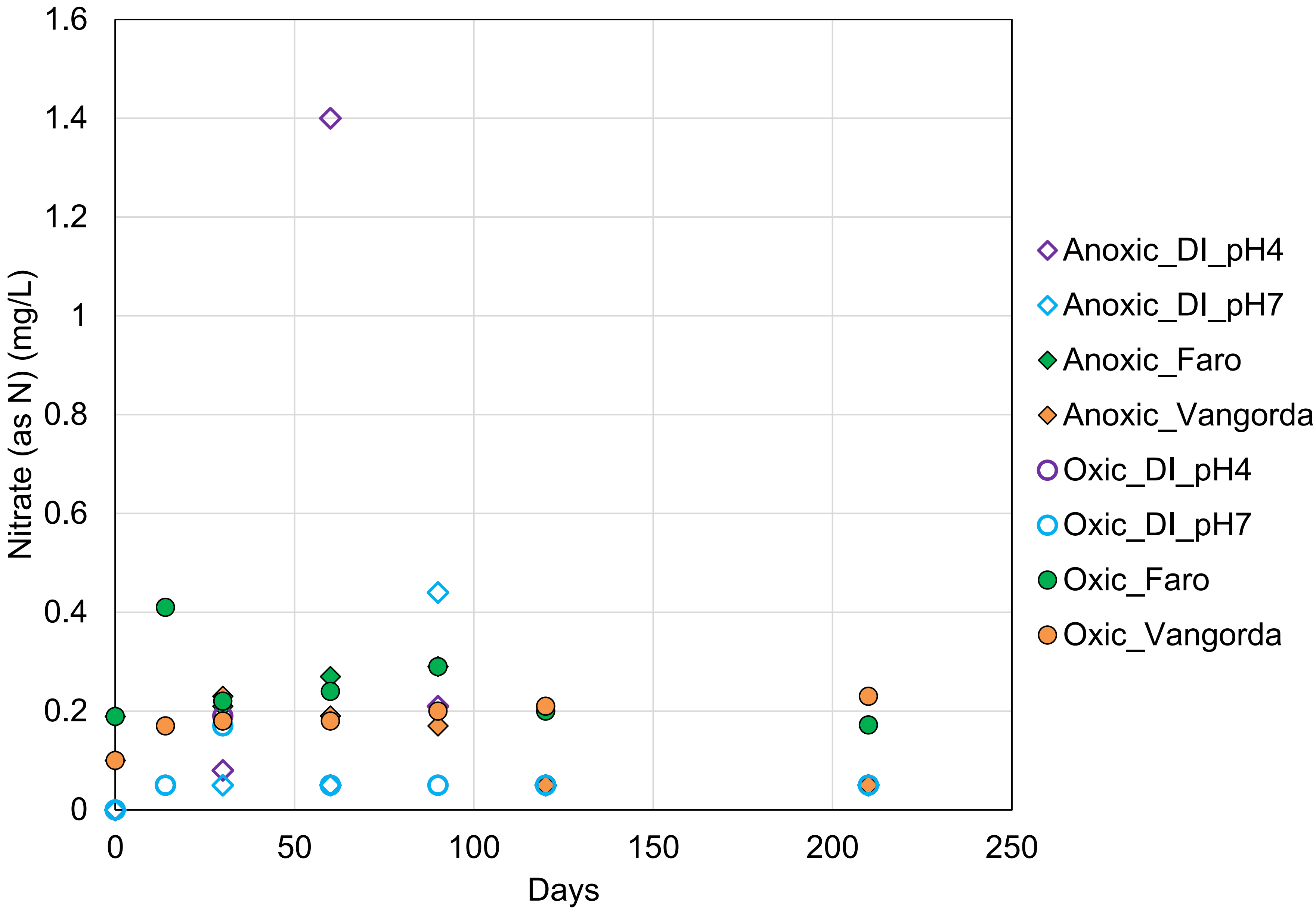

Alkalinity (to pH 4.5) (mg CaCO3/L)
60
50
40
30
20
10
0
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

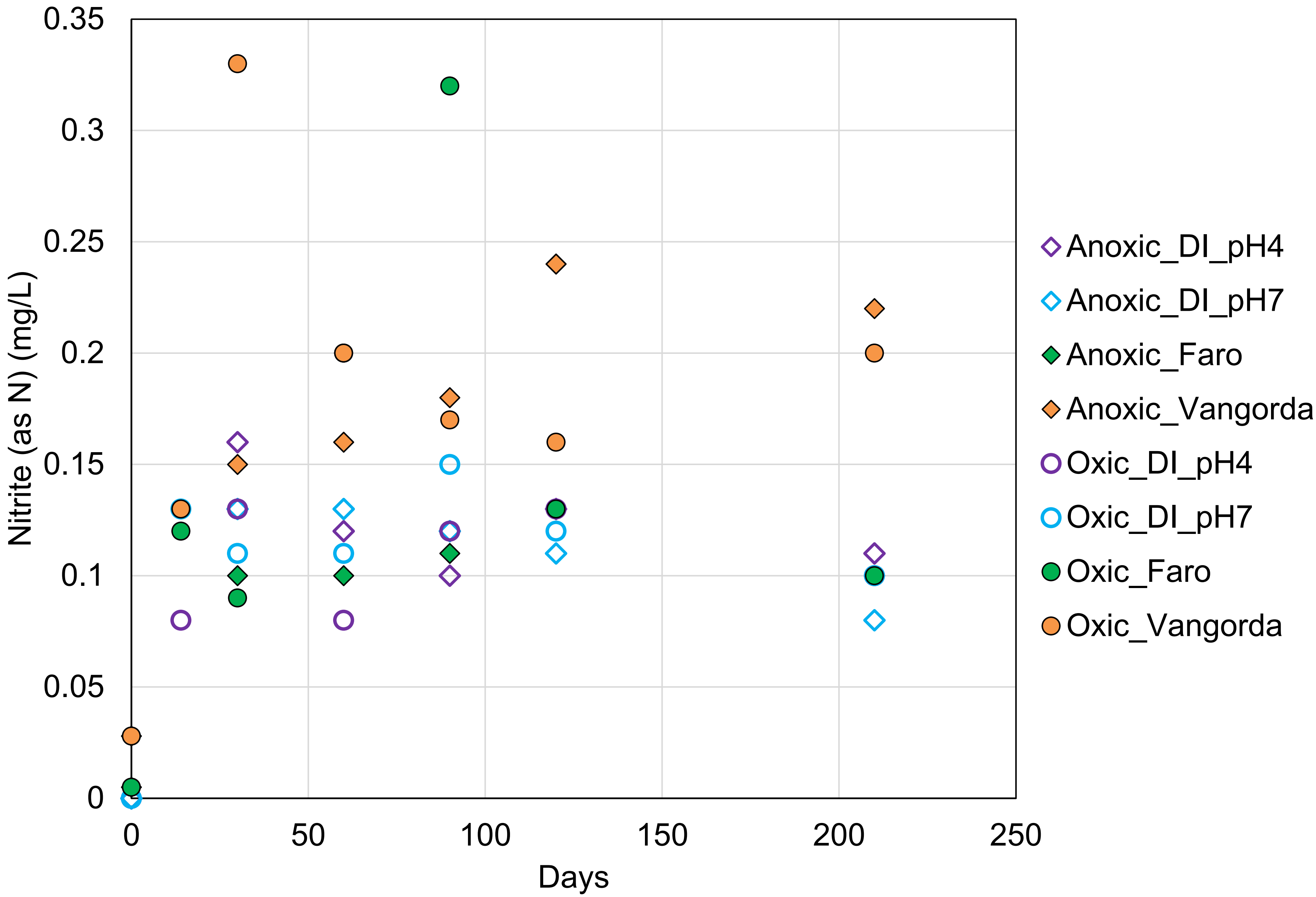

Dissolved Sulphate (SO4) (mg/L)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

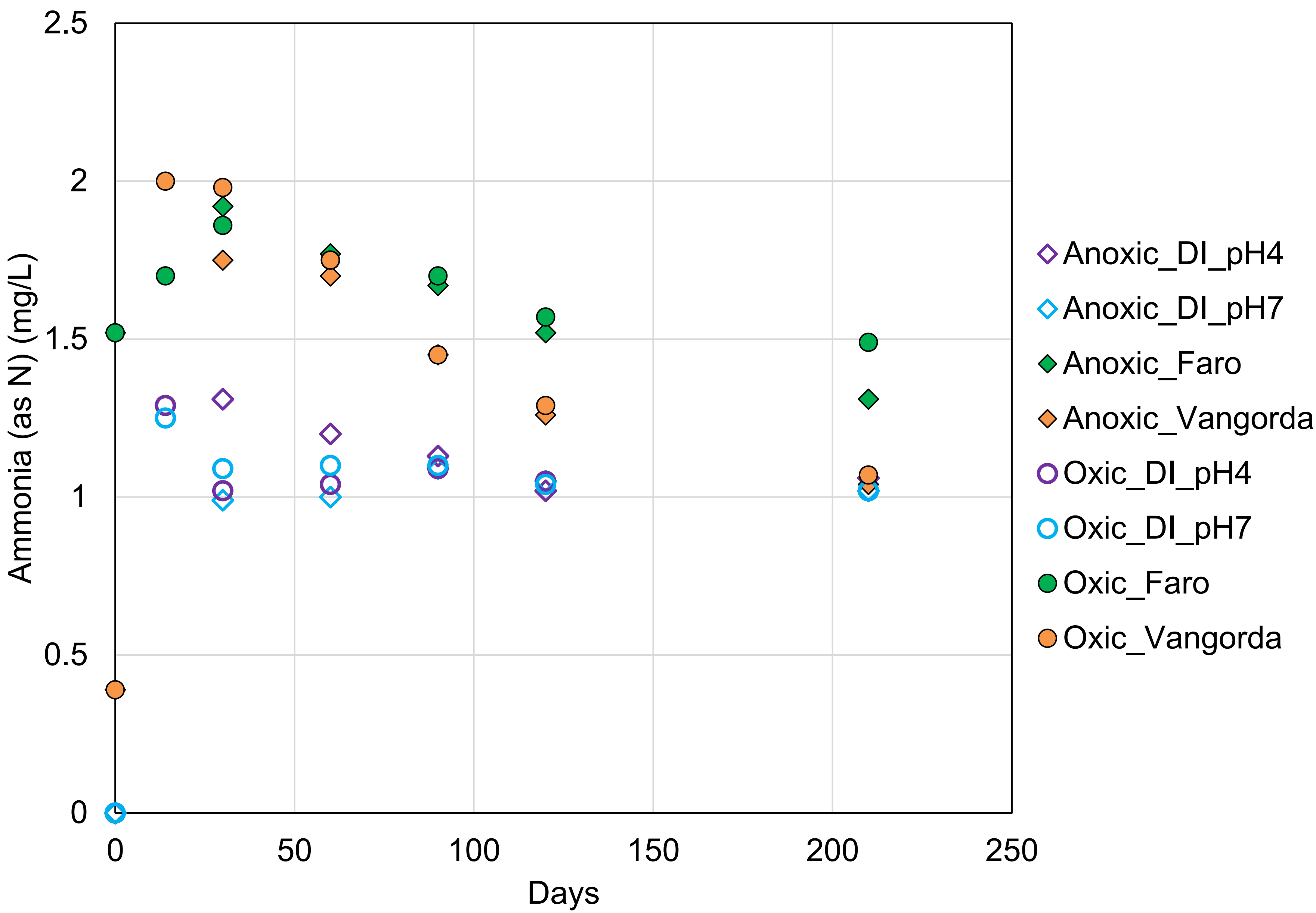

Chloride (mg/L)
3
2.5
2
1.5
1
0.5
0
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

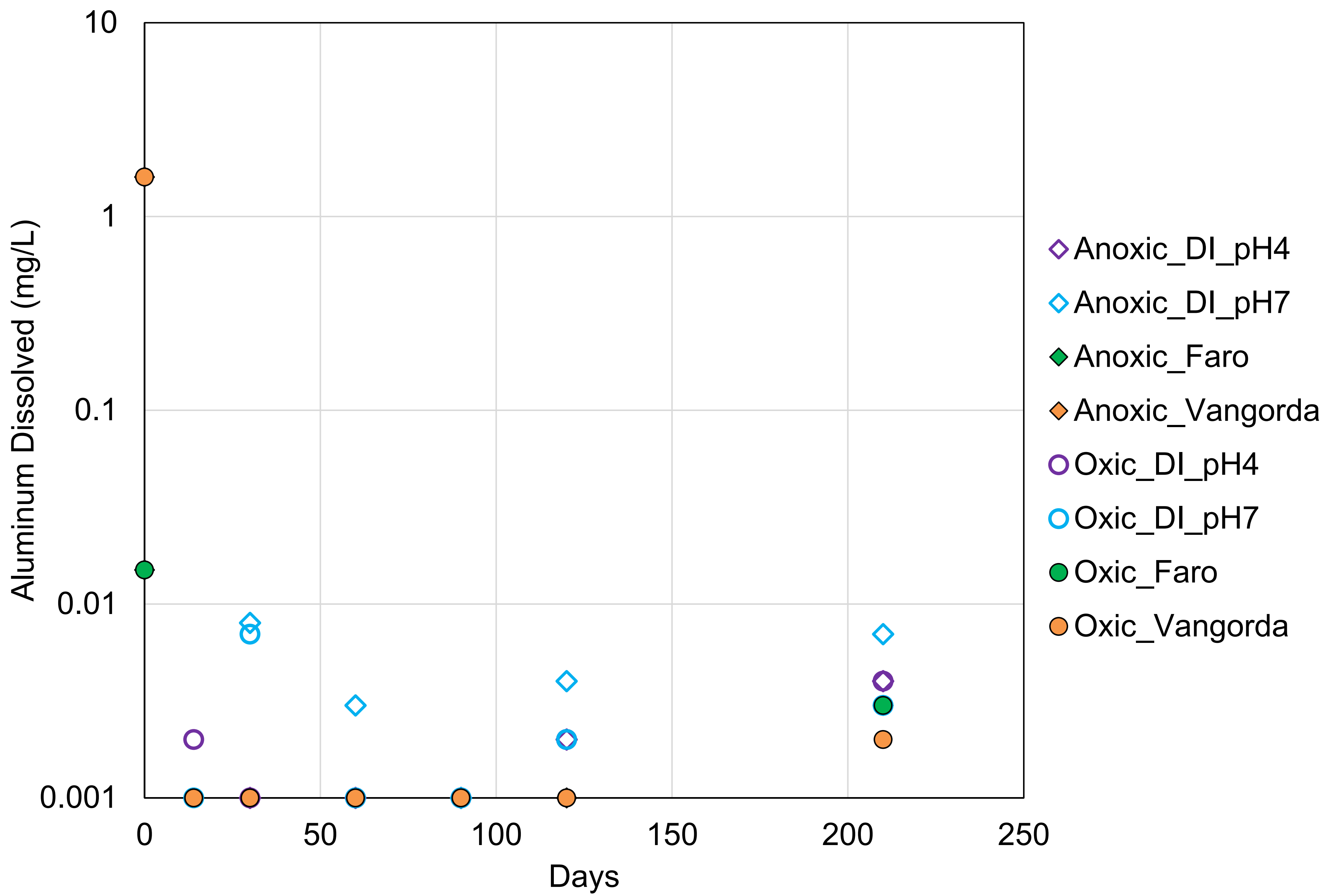

0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Fluoride (mg/L)
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

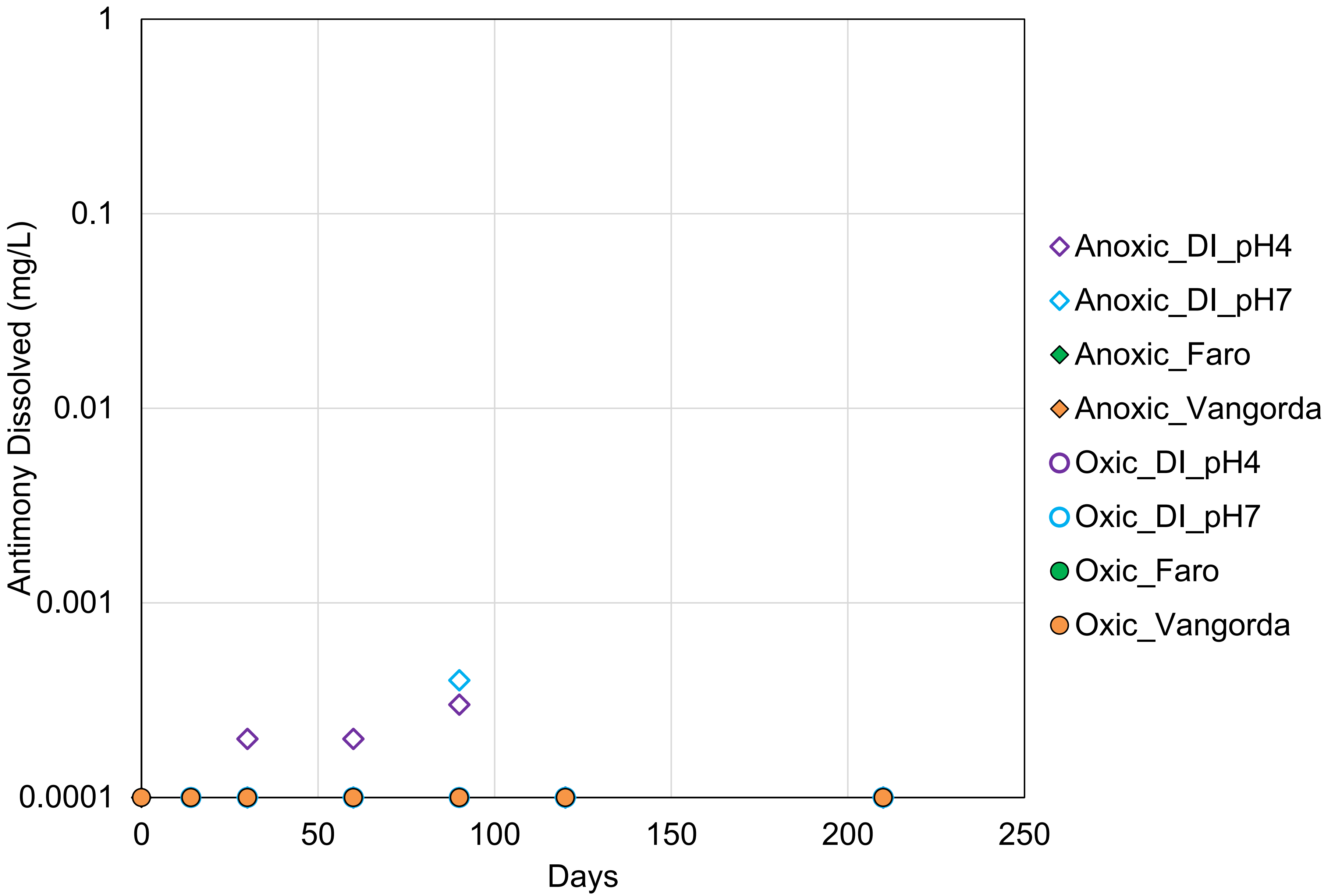

0.6
0.5
0.4
0.3
0.2
0.1
0
Bromide (mg/L)
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro

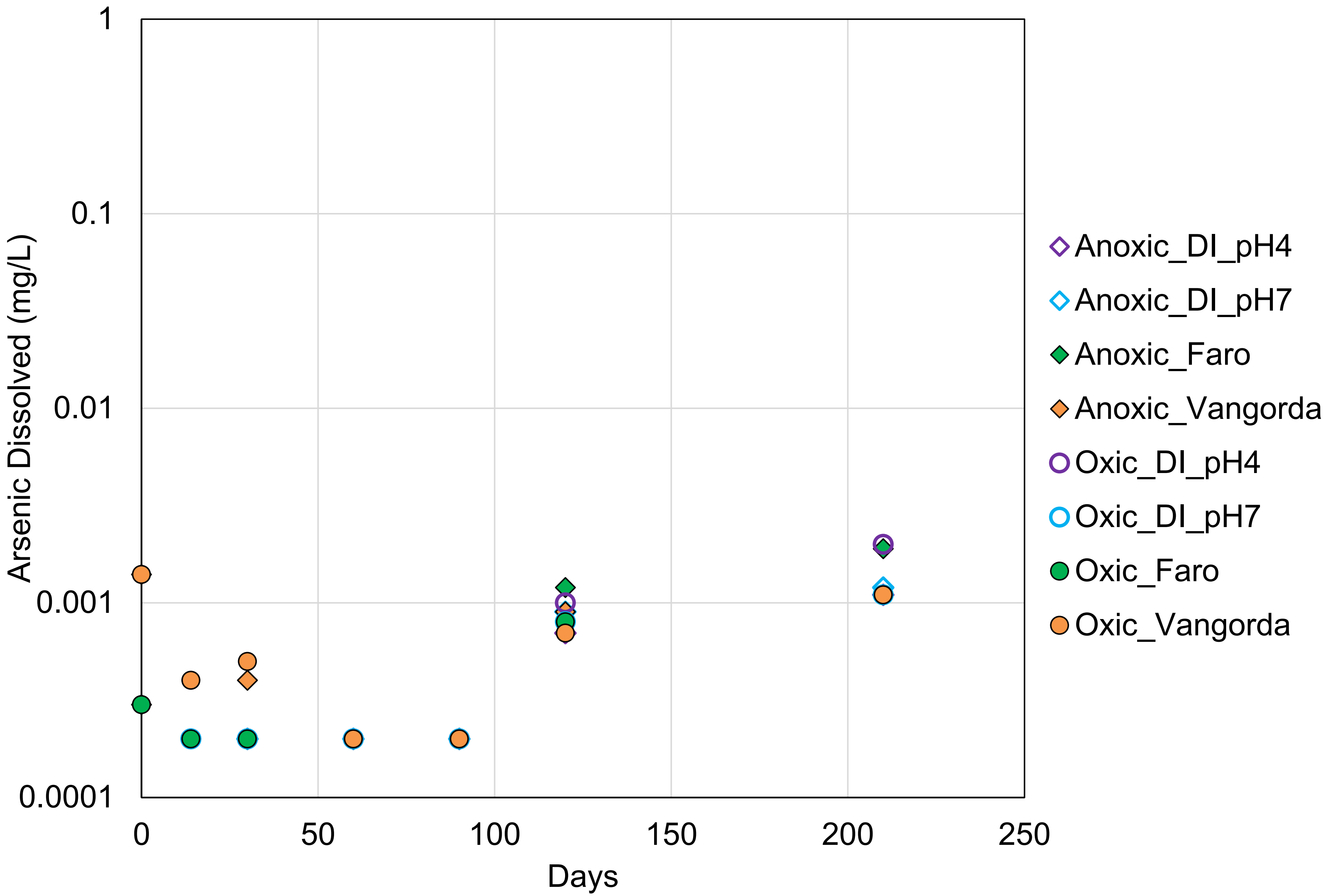

1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Nitrate (as N) (mg/L)
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

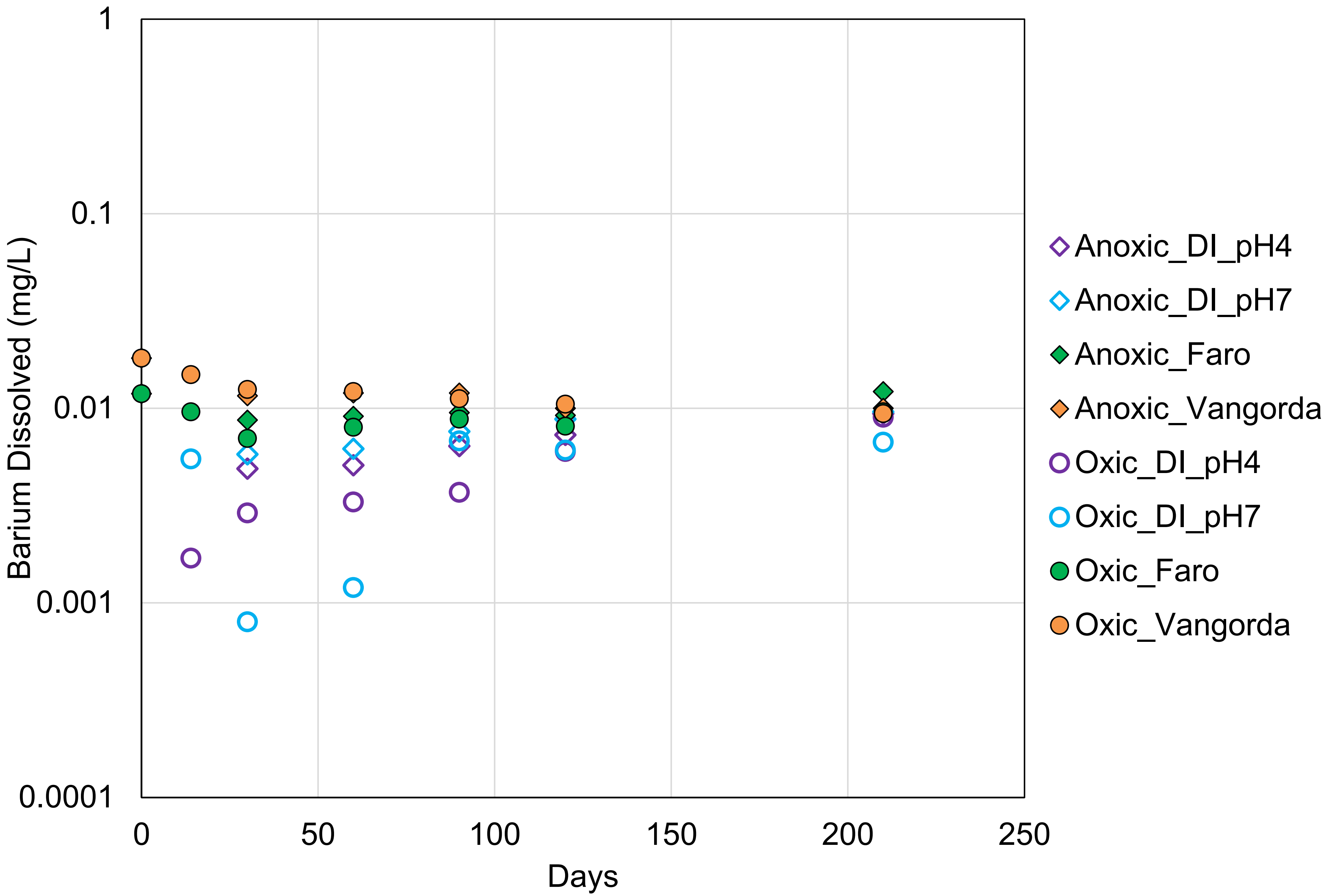

0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Nitrite (as N) (mg/L)
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

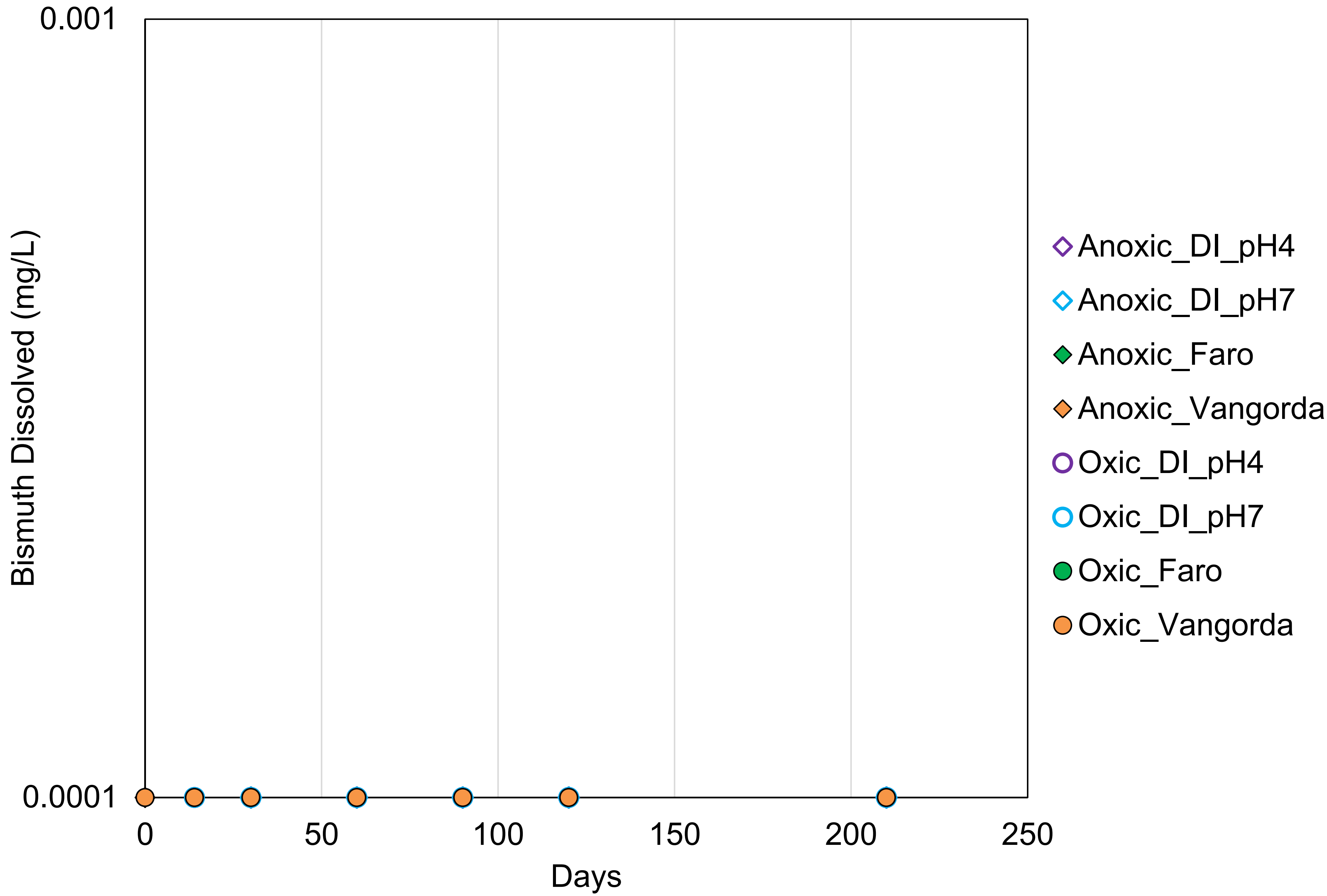

Ammonia (as N) (mg/L)
2.5
2
1.5
1
0.5
0
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

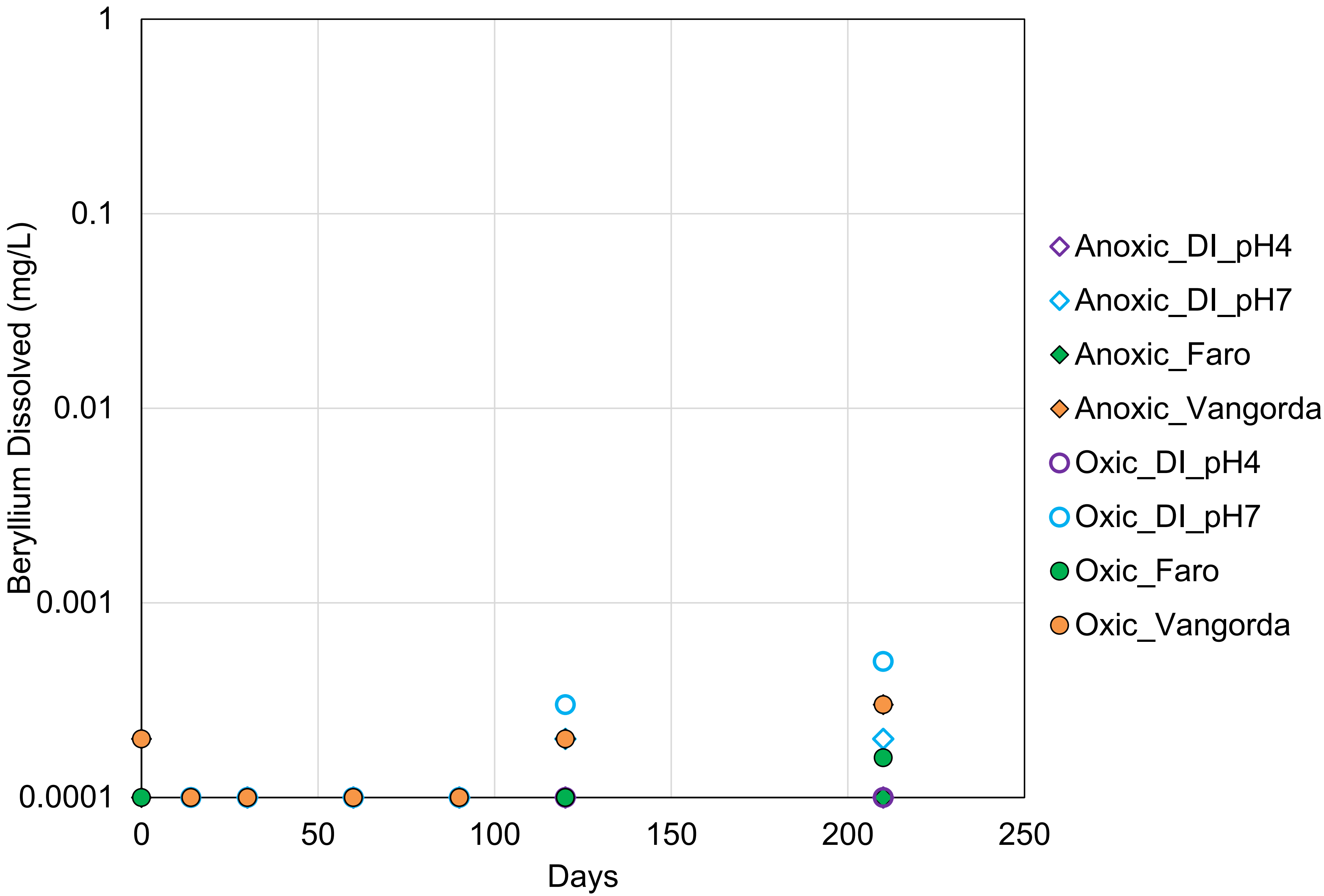

10
1
0.1
0.01
0.001
Aluminum Dissolved (mg/L)
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

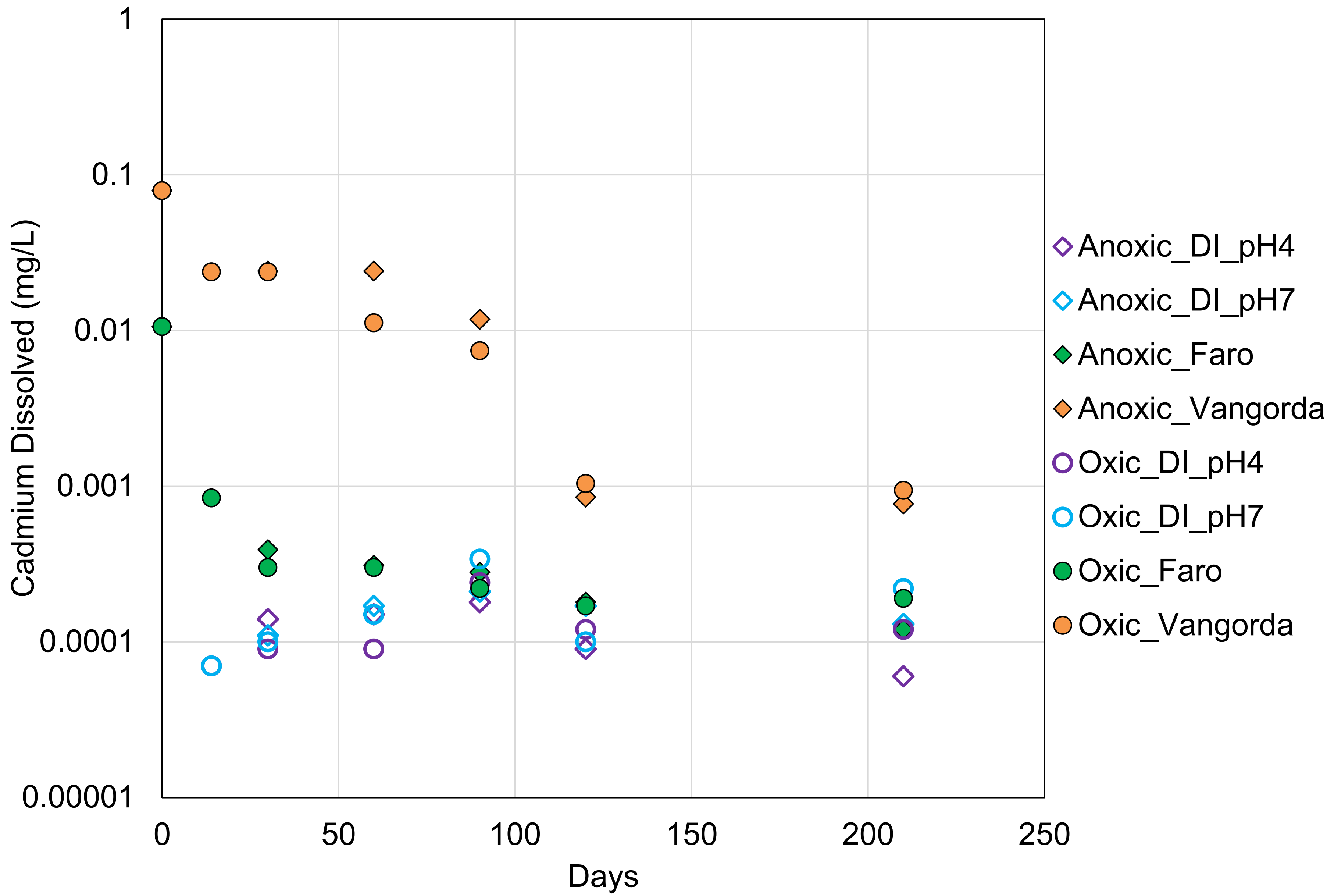

1
0.1
0.01
0.001
0.0001
Antimony Dissolved (mg/L)
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

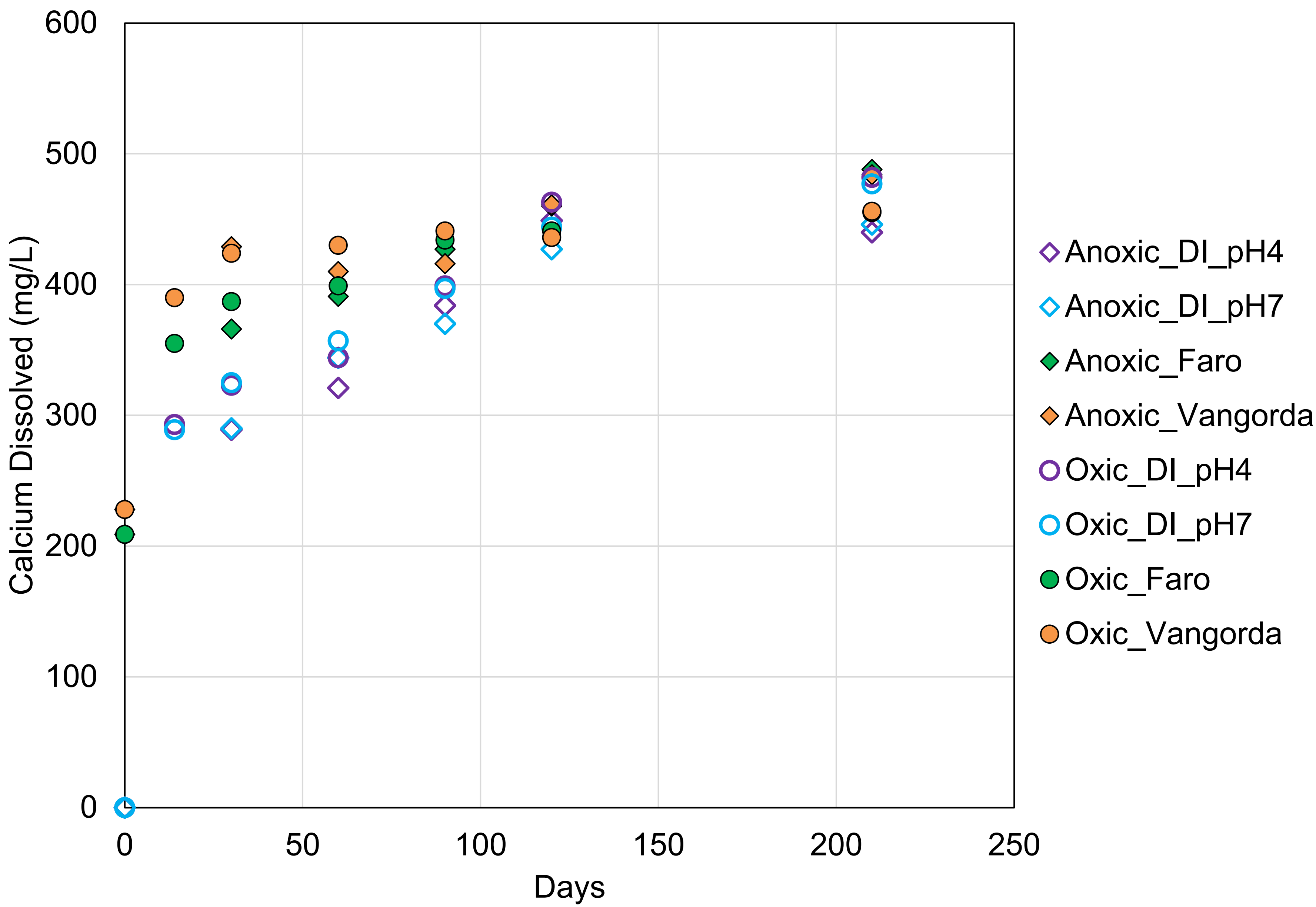

Arsenic Dissolved (mg/L)
1
0.1
0.01
0.001
0.0001
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

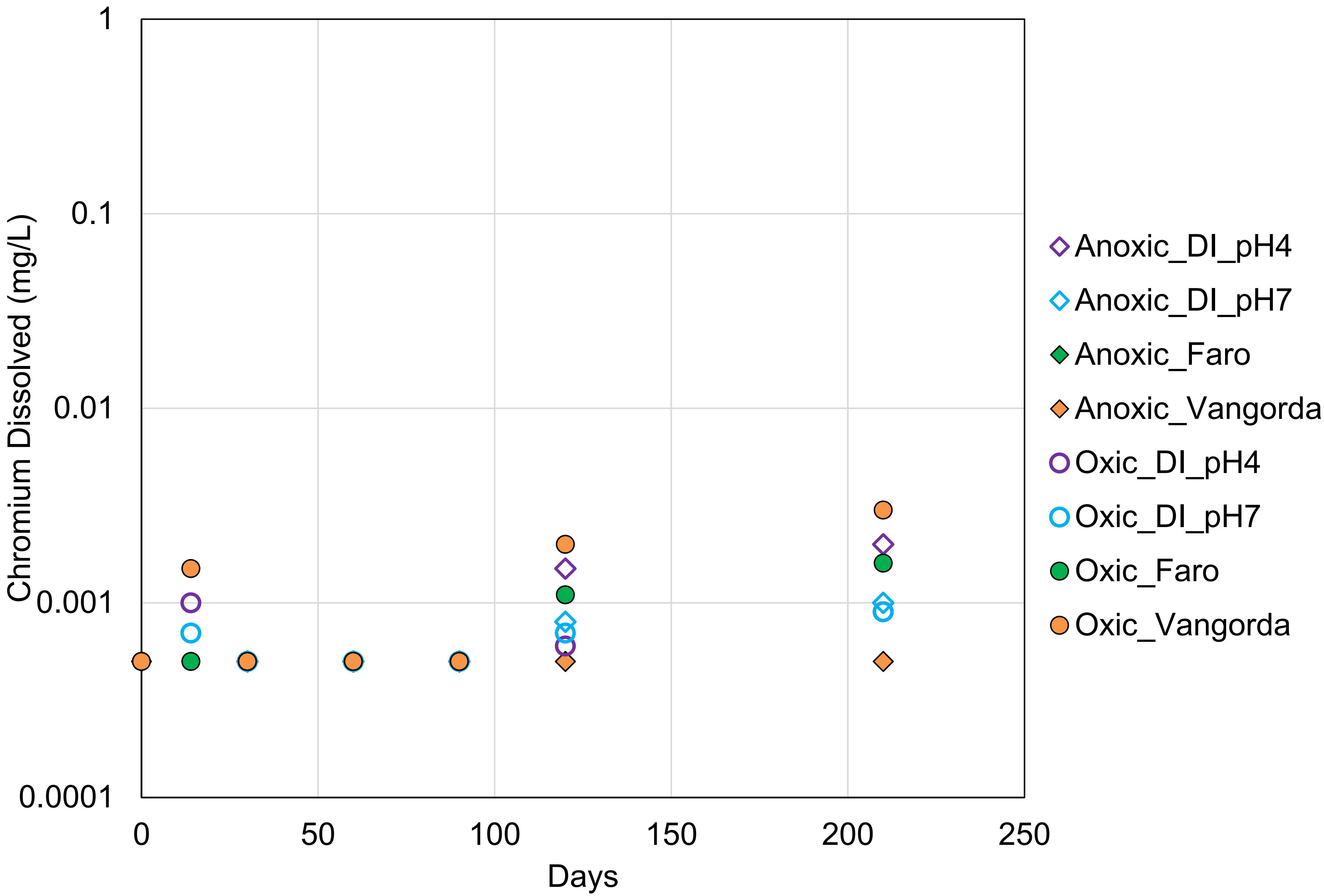

Barium Dissolved (mg/L)
1
0.1
0.01
0.001
0.0001
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

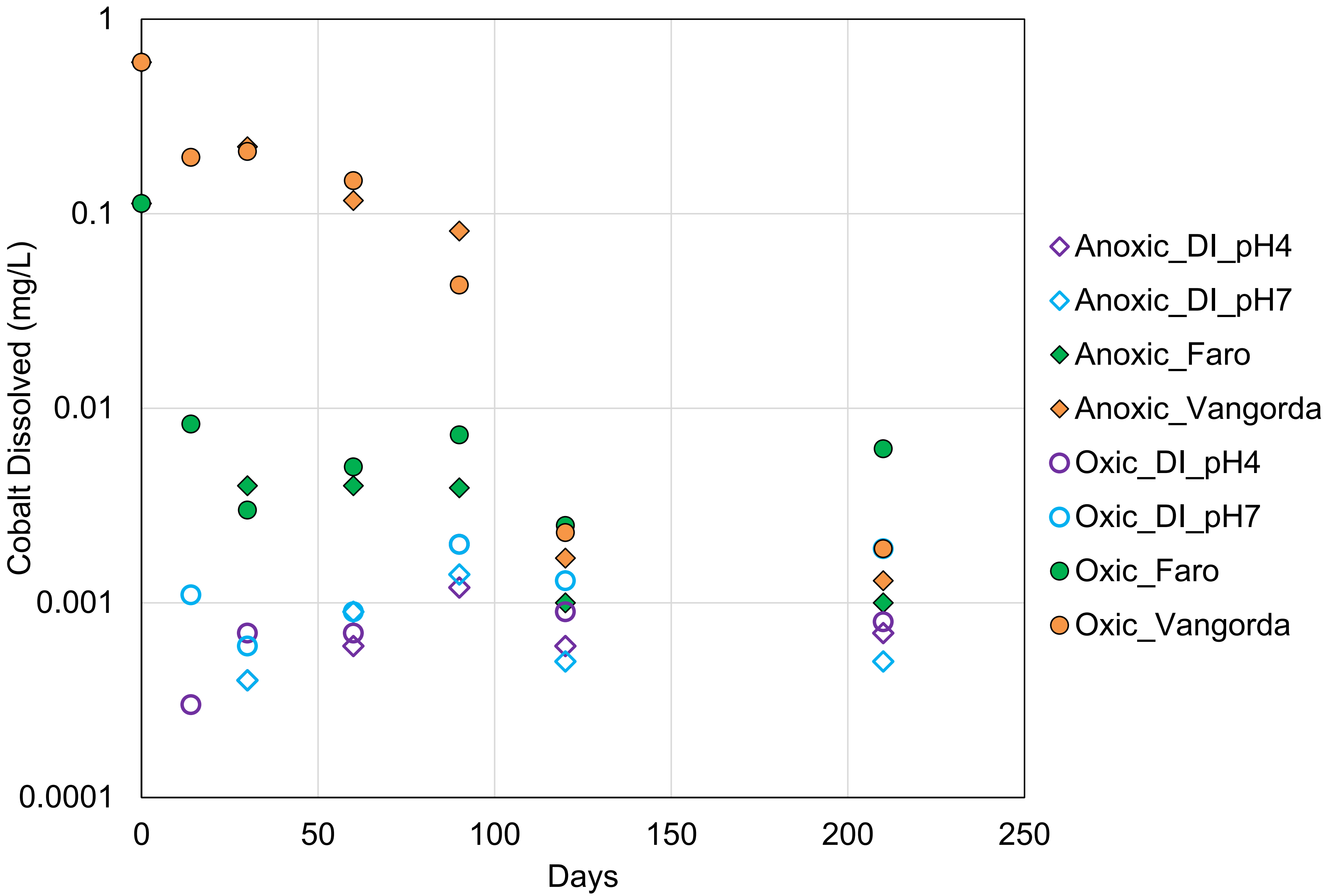

0.001
0.0001
Bismuth Dissolved (mg/L)
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

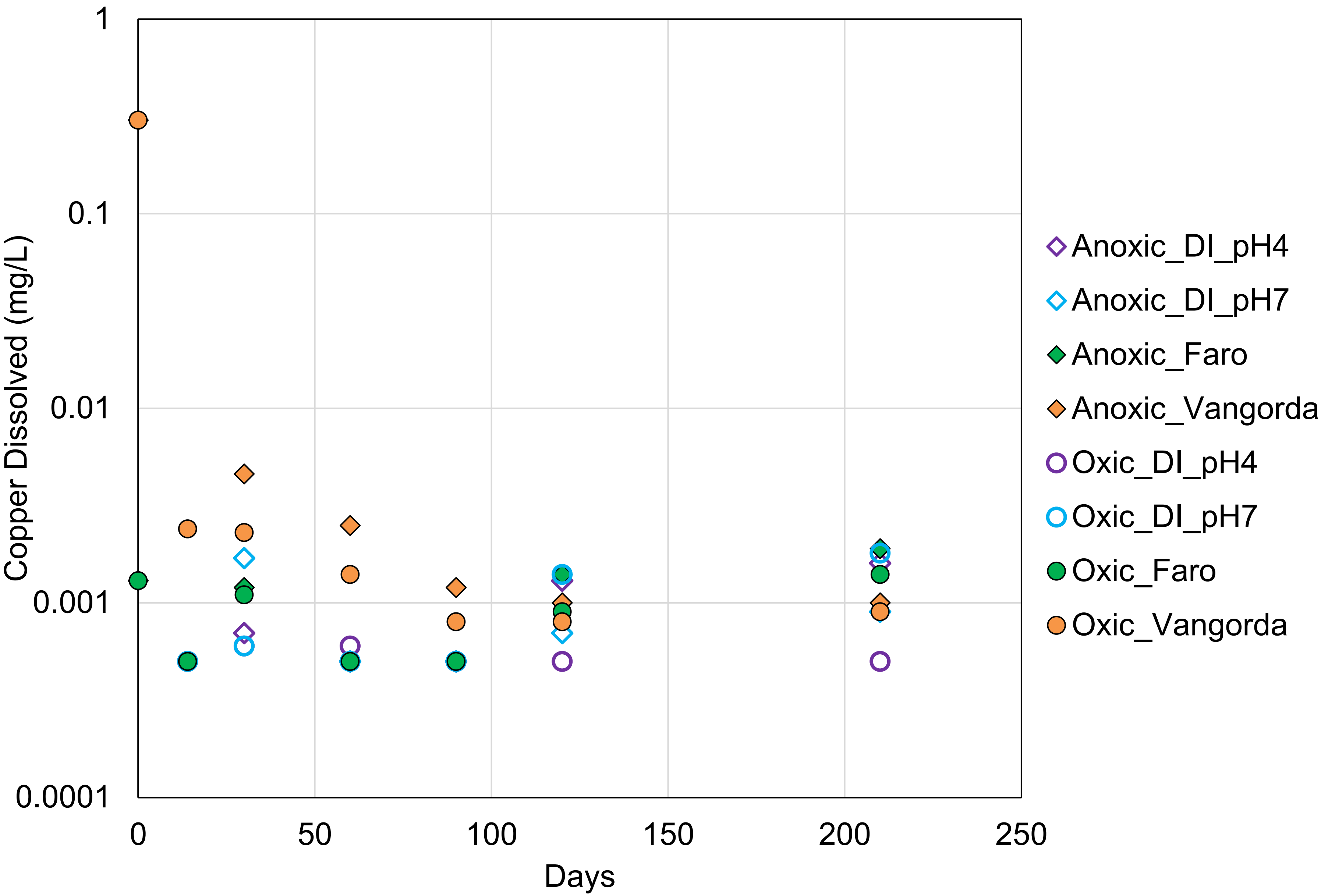

1
0.1
0.01
0.001
0.0001
Beryllium Dissolved (mg/L)
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

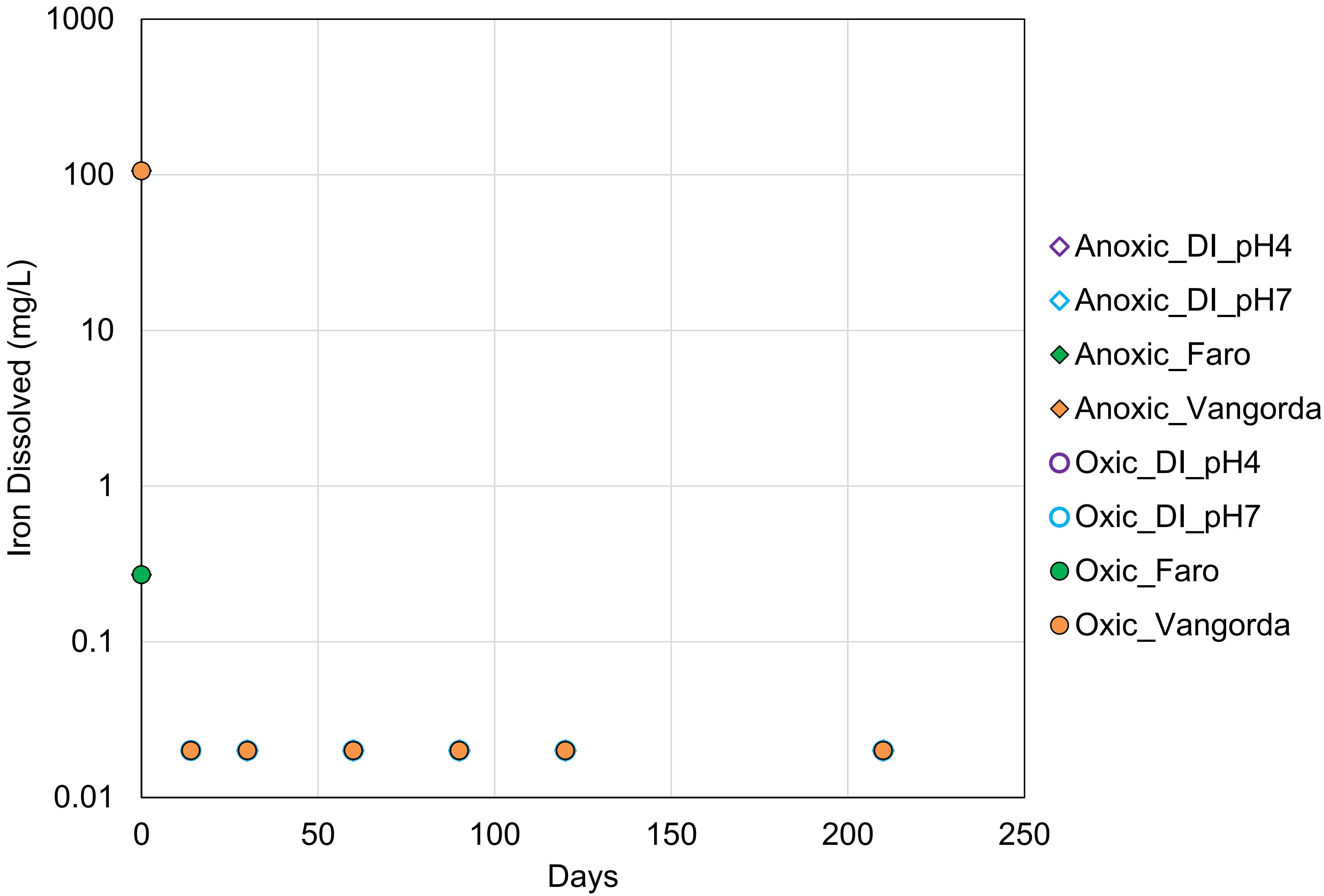

1
0.1
0.01
0.001
0.0001
0.00001
Cadmium Dissolved (mg/L)
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

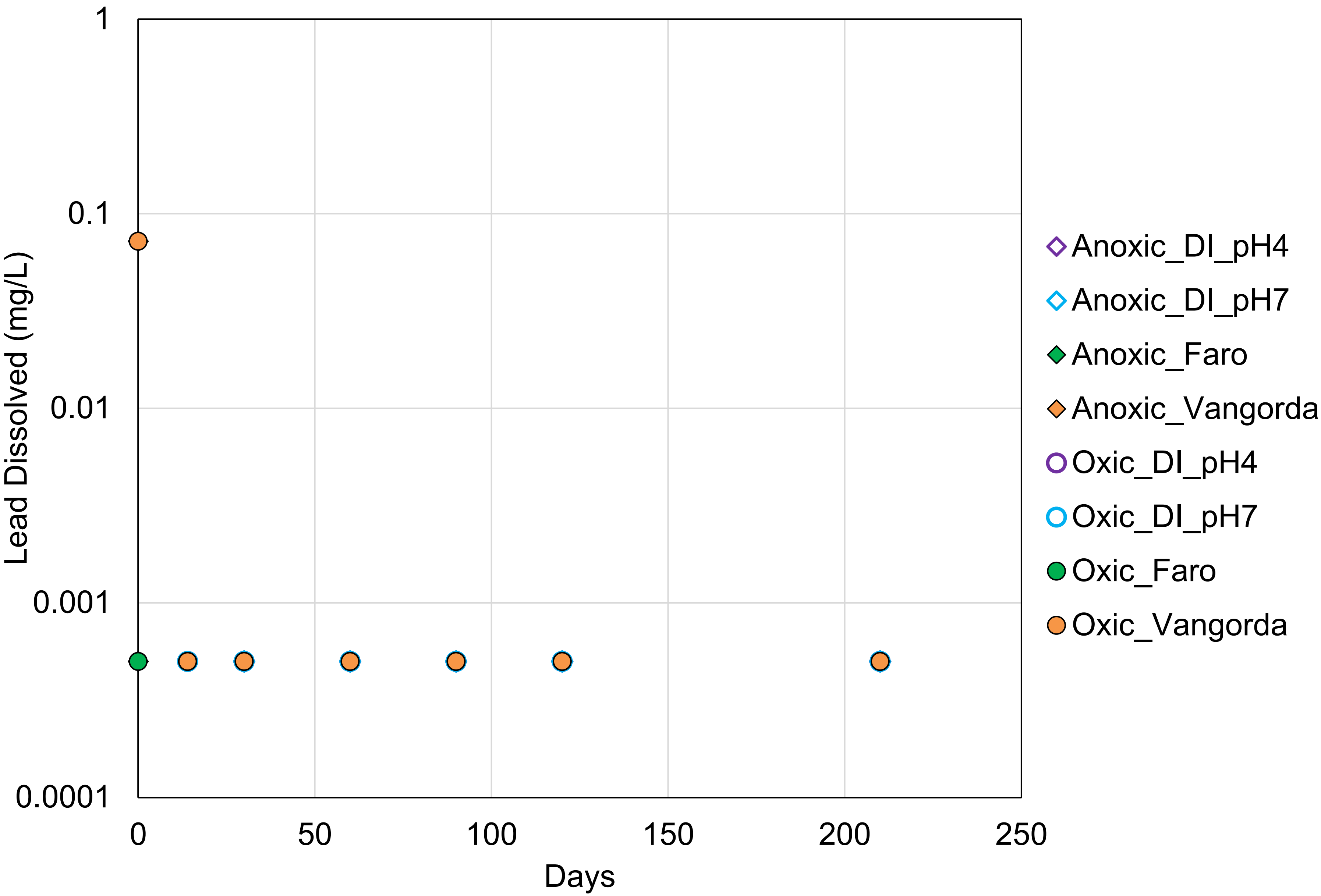

Calcium Dissolved (mg/L)
600
500
400
300
200
100
0
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

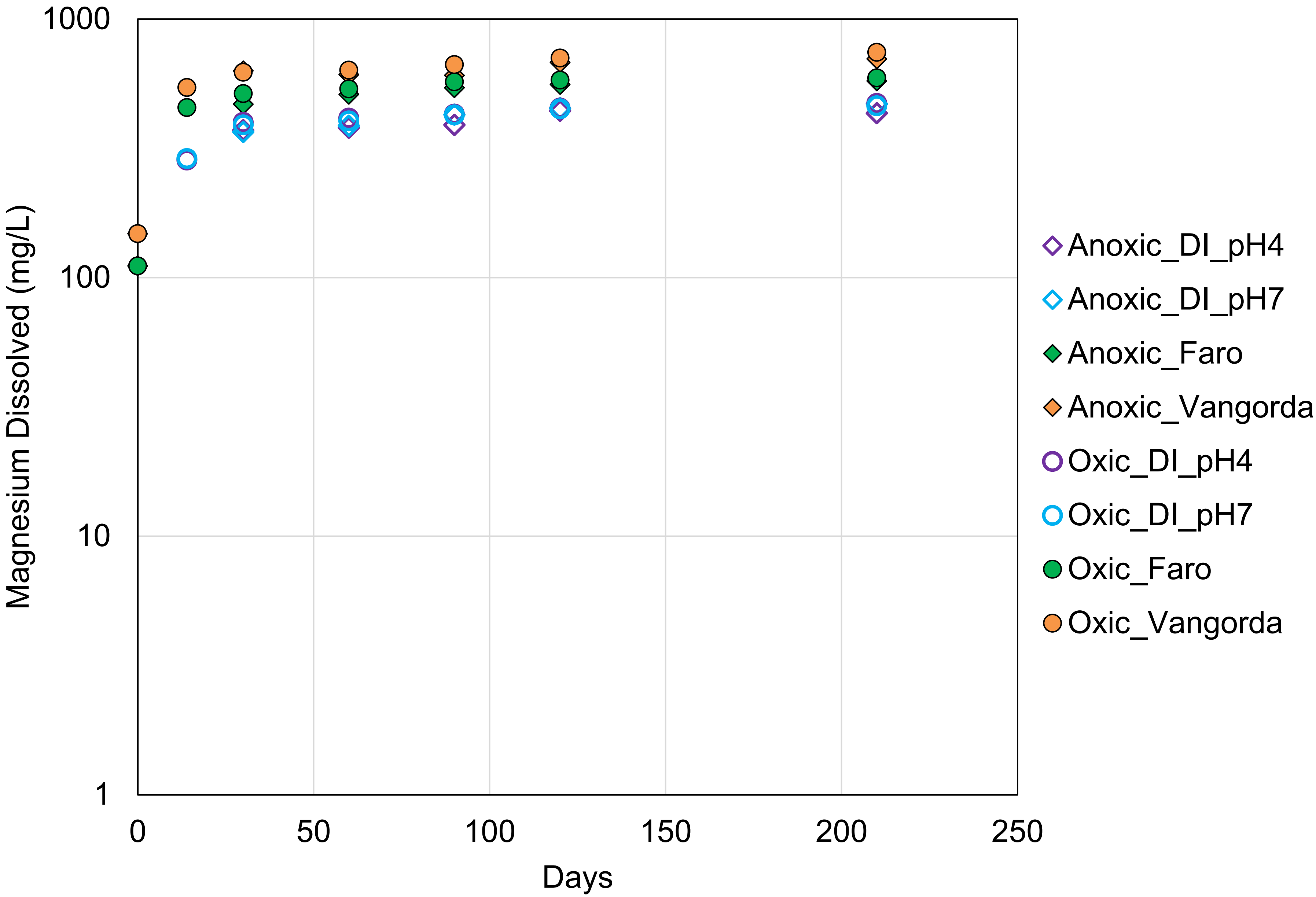

Chromium Dissolved (mg/L)
1
0.1
0.01
0.001
0.0001
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

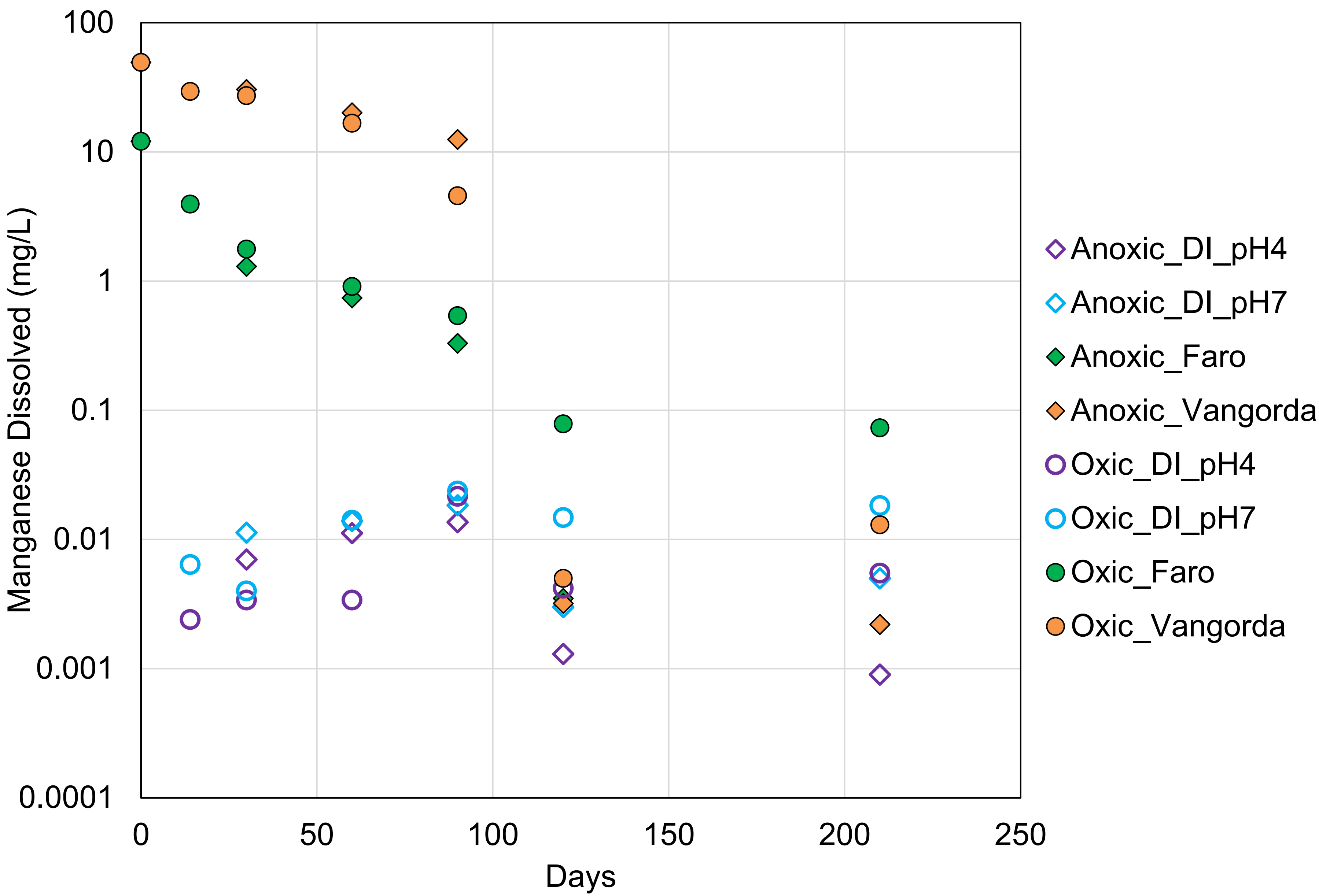

Cobalt Dissolved (mg/L)
1
0.1
0.01
0.001
0.0001
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

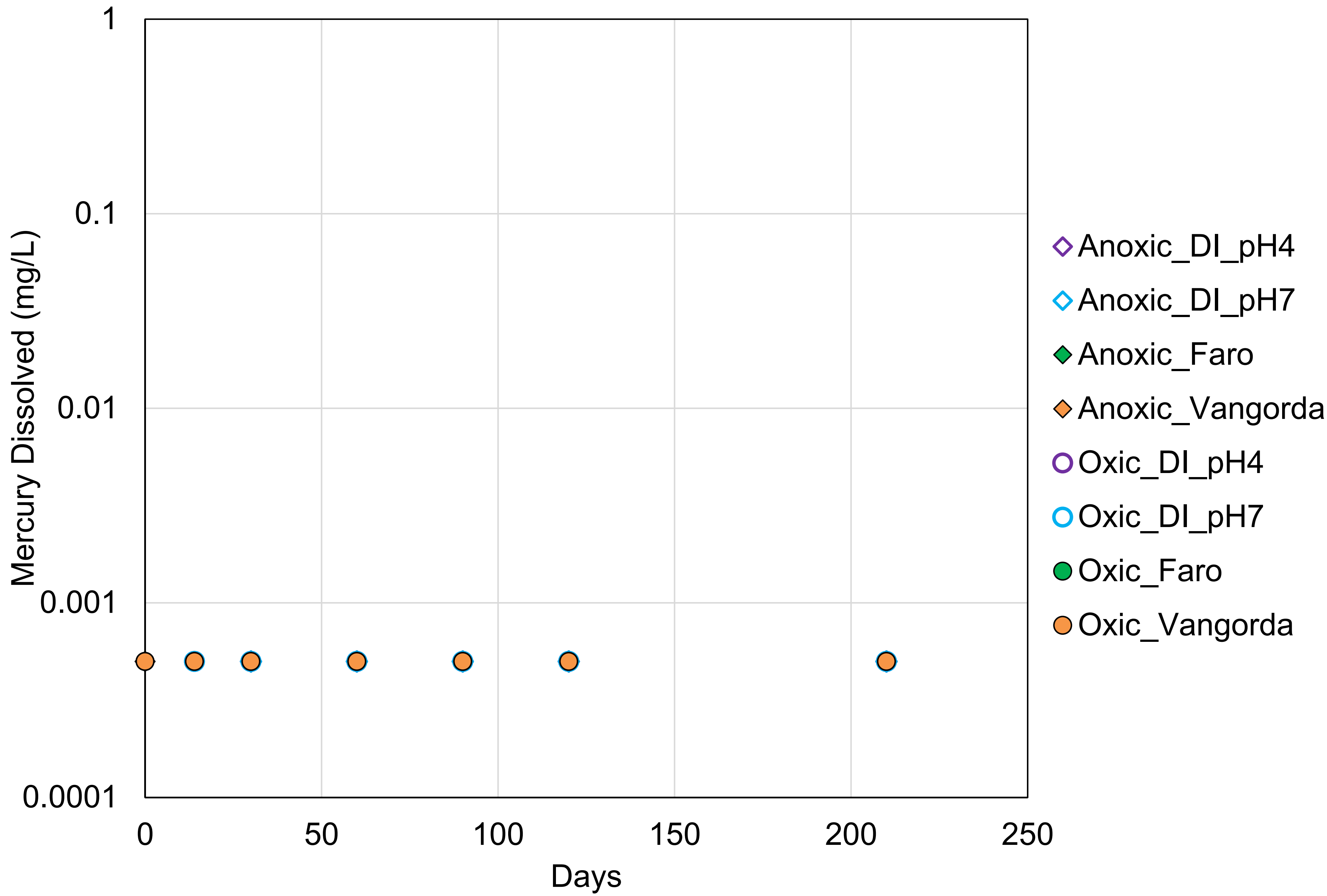

Copper Dissolved (mg/L)
1
0.1
0.01
0.001
0.0001
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

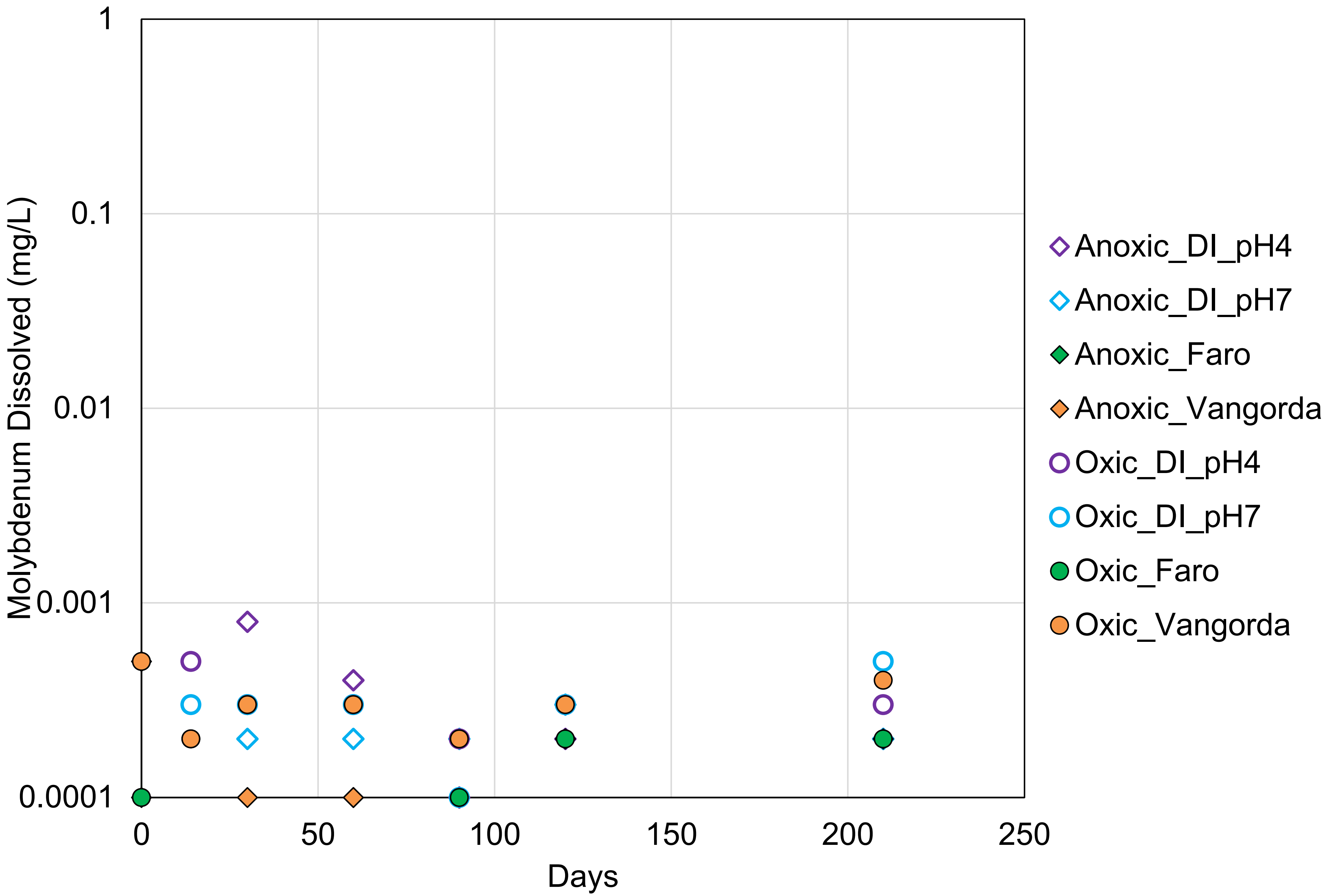

1000
100
10
1
0.1
0.01
Iron Dissolved (mg/L)
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

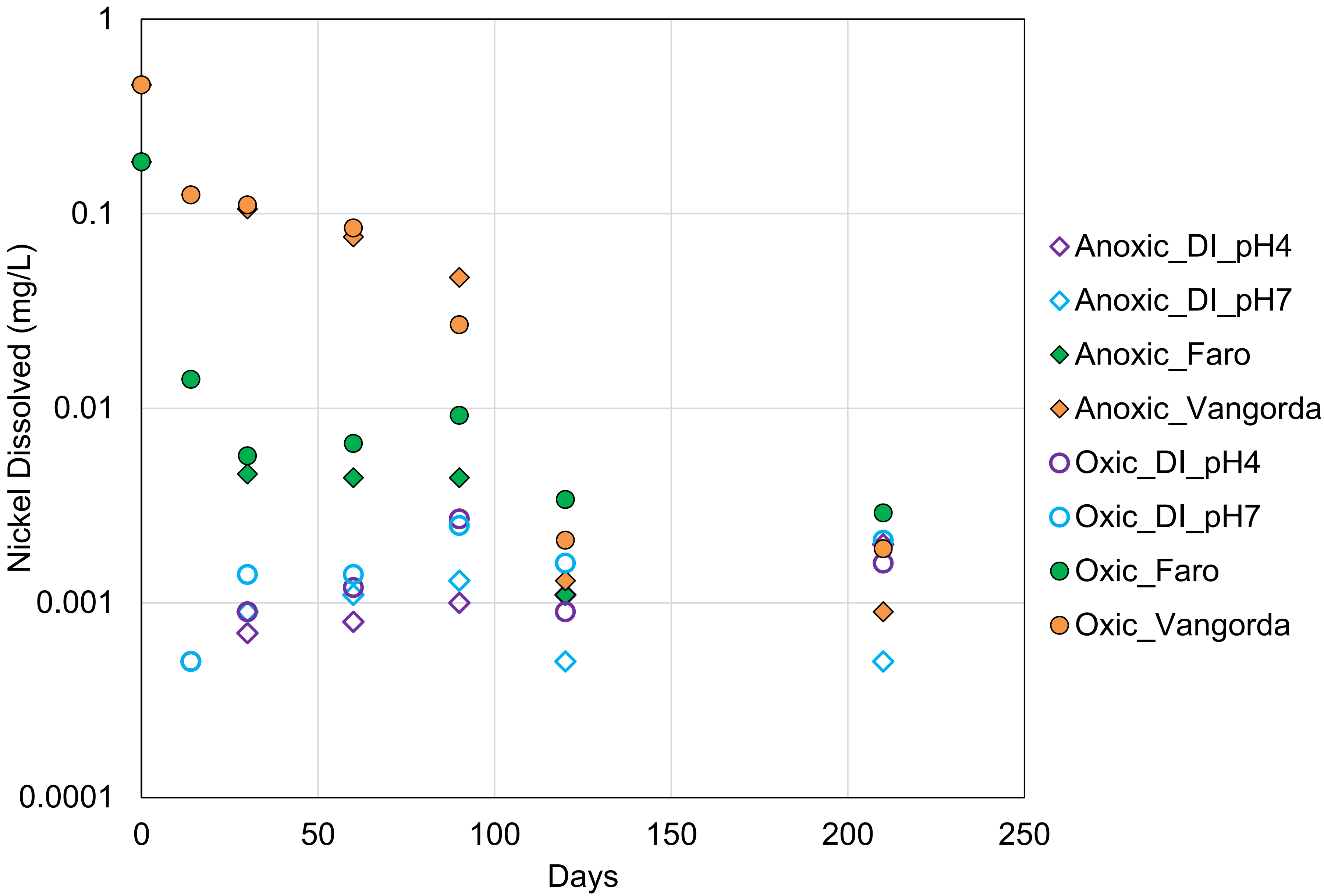

1
0.1
0.01
0.001
0.0001
Lead Dissolved (mg/L)
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

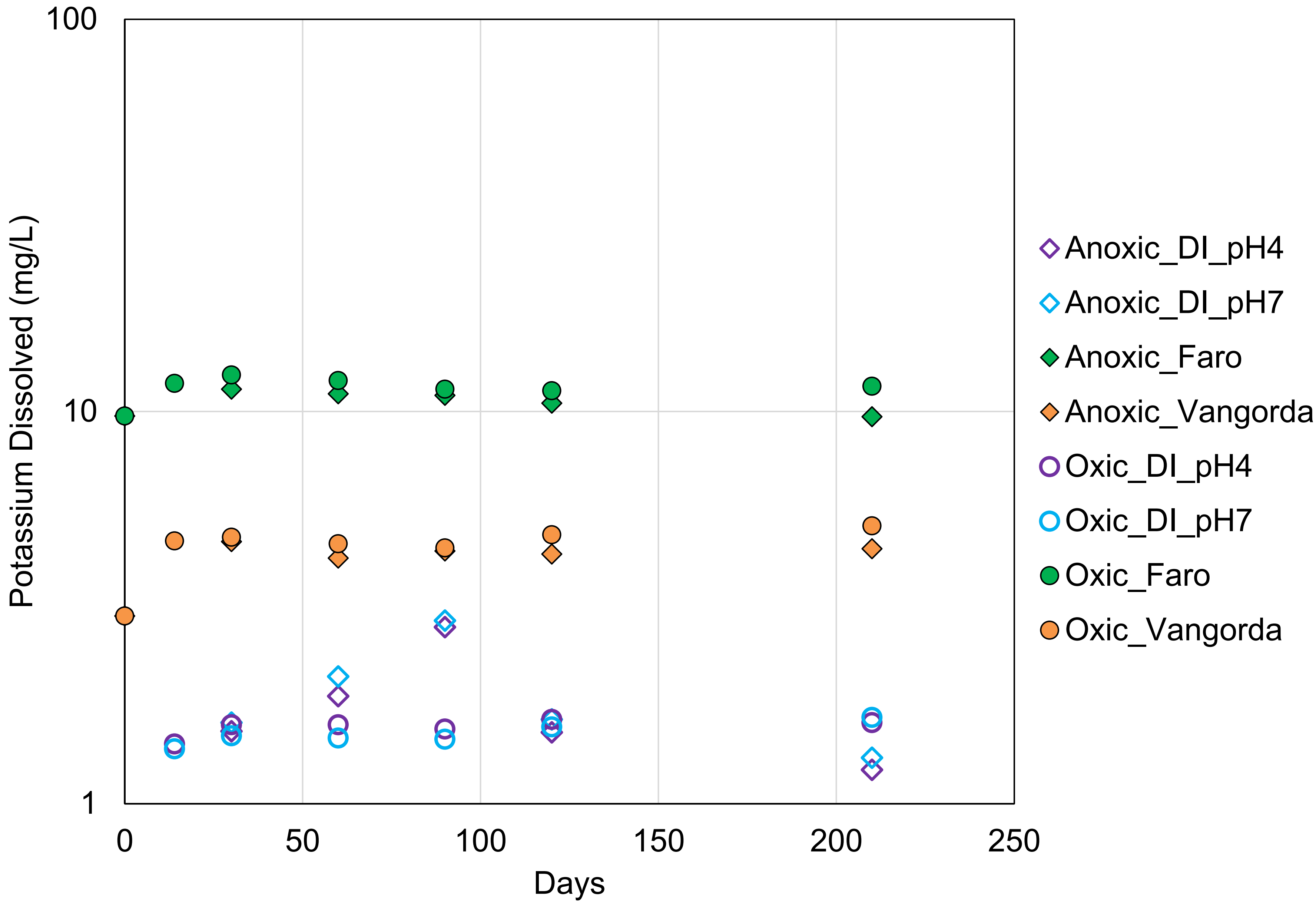

1000
100
10
1
Magnesium Dissolved (mg/L)
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

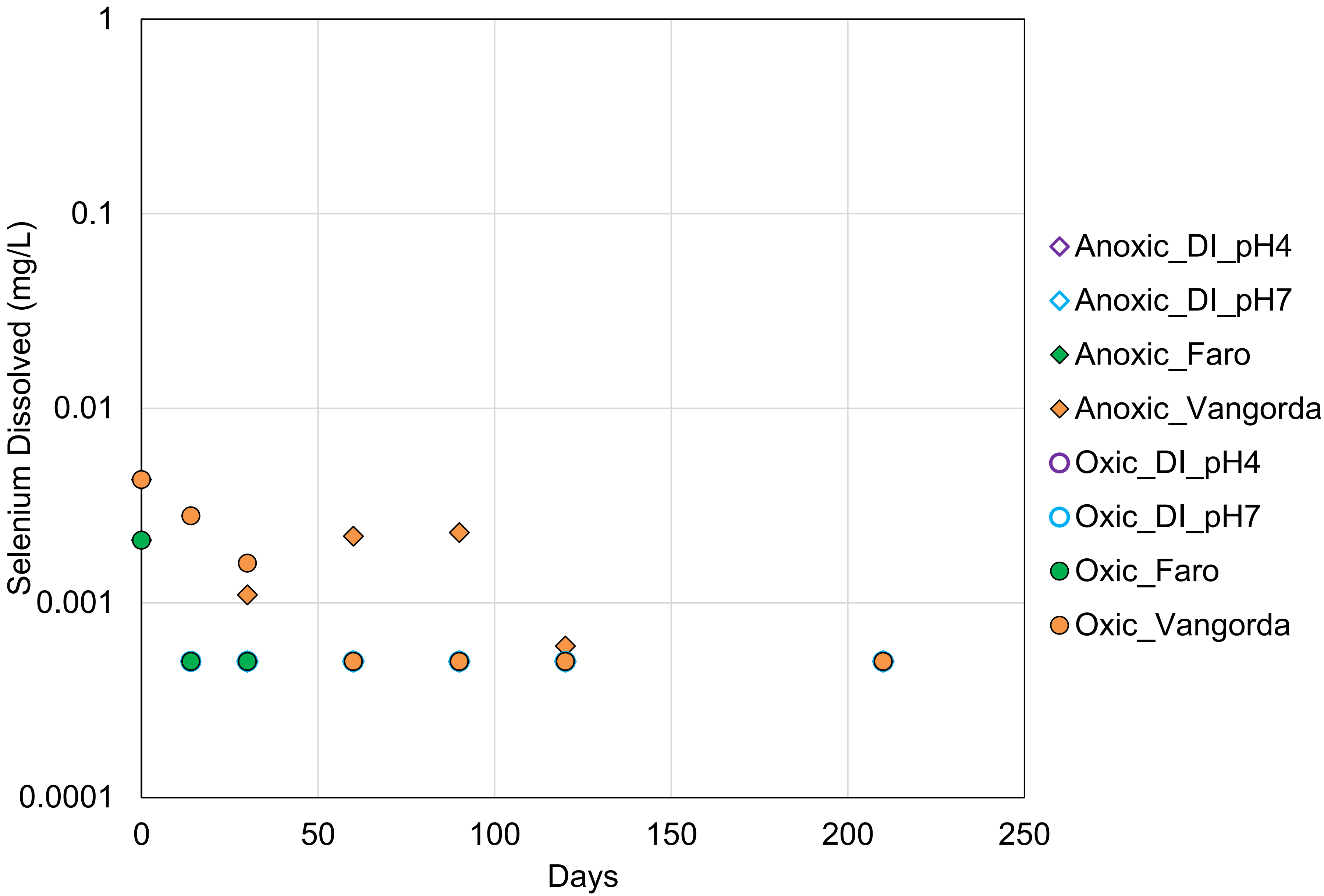

Manganese Dissolved (mg/L)
100
10
1
0.1
0.01
0.001
0.0001
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda


1
0.1
0.01
0.001
0.0001
Mercury Dissolved (mg/L)
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

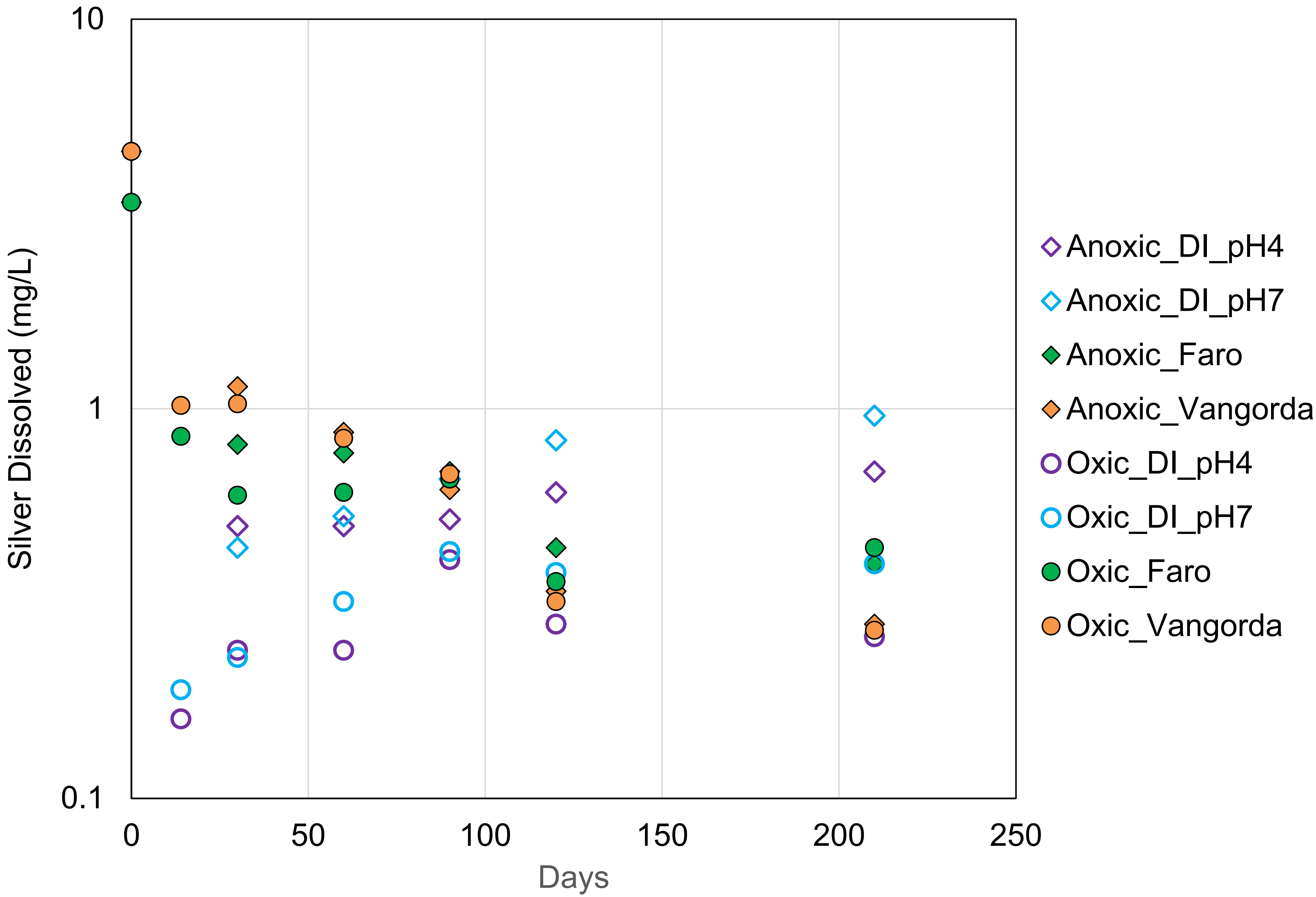

1
0.1
0.01
0.001
0.0001
Molybdenum Dissolved (mg/L)
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

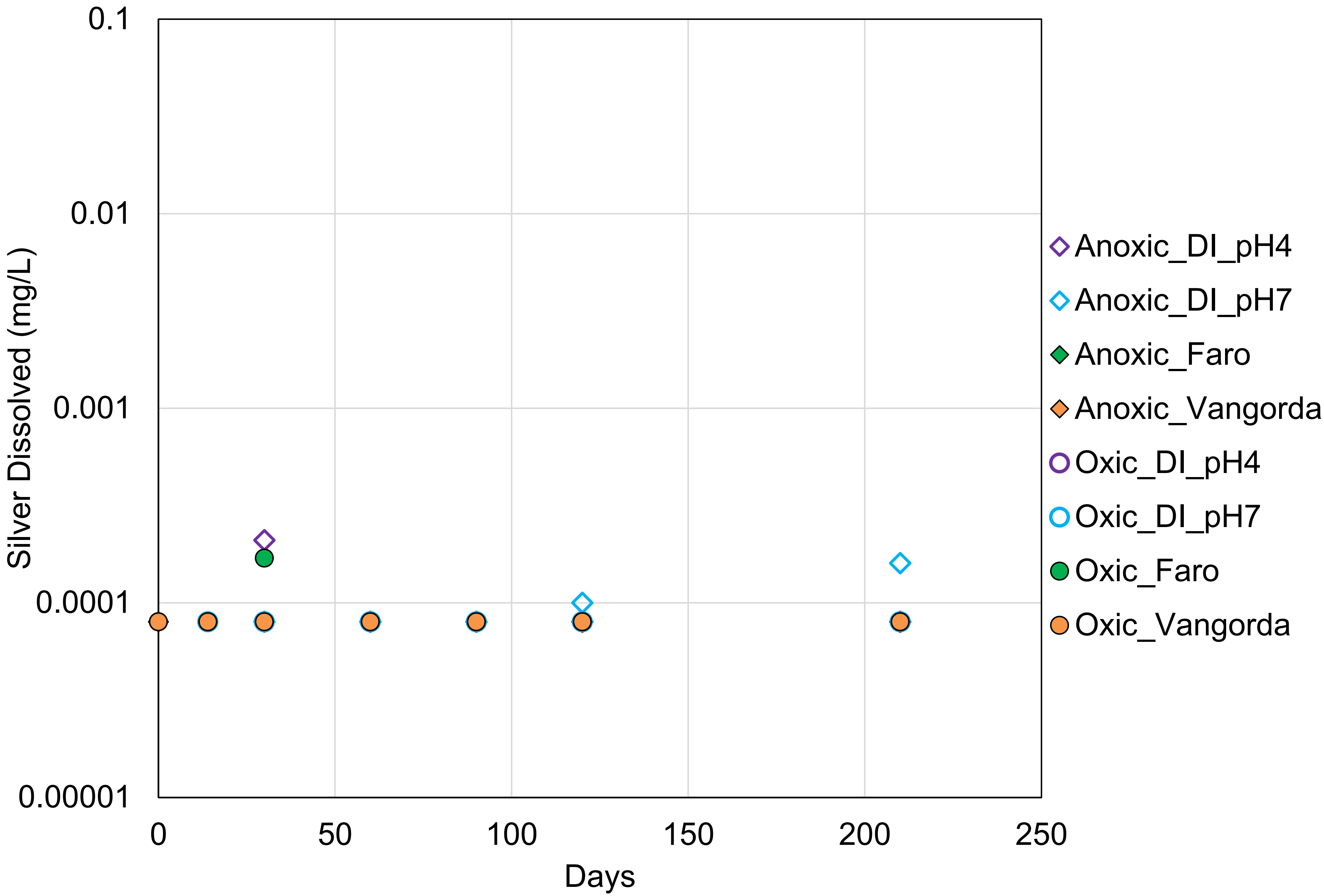

1
0.1
0.01
0.001
0.0001
Nickel Dissolved (mg/L)
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

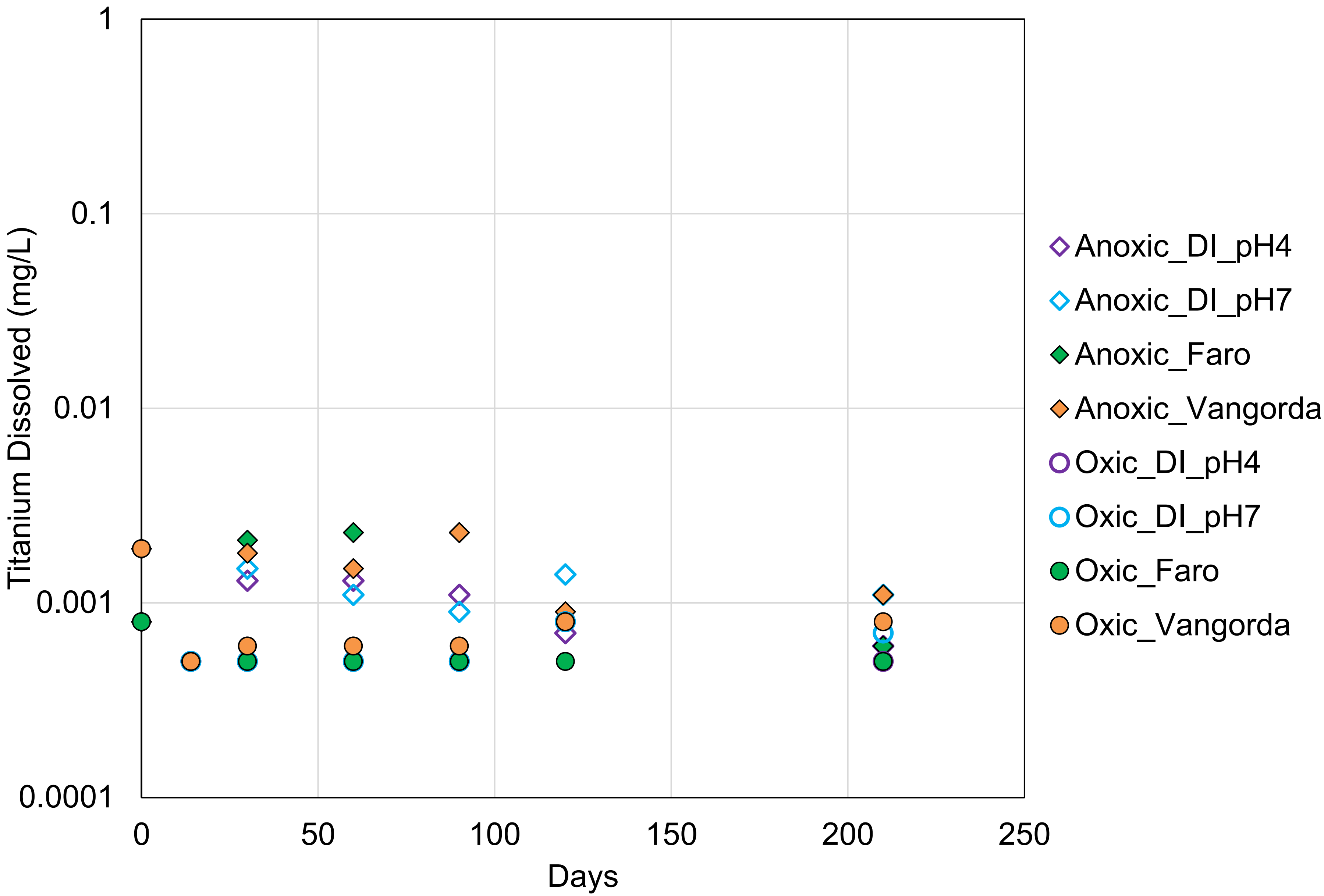

100
10
1
Potassium Dissolved (mg/L)
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

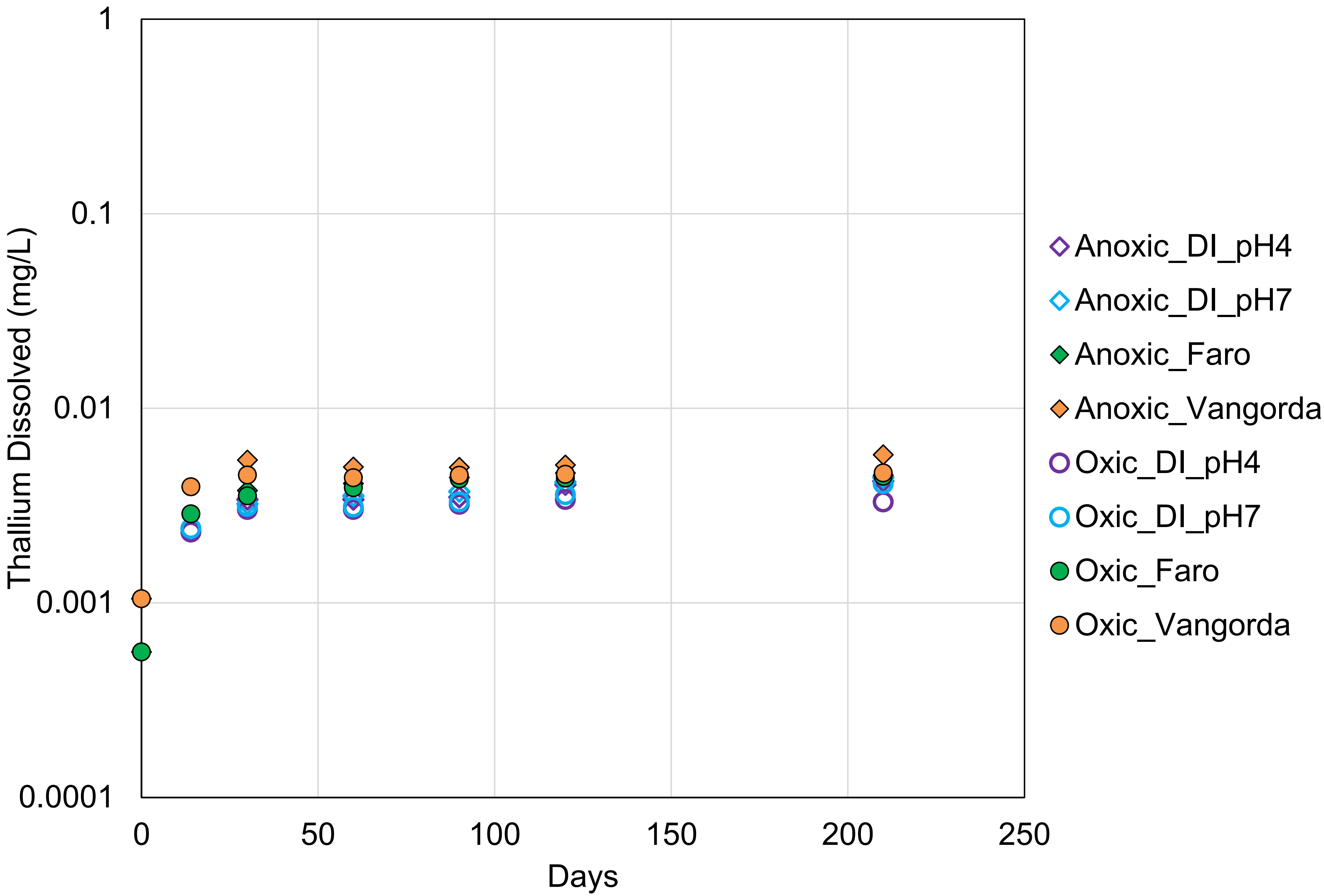


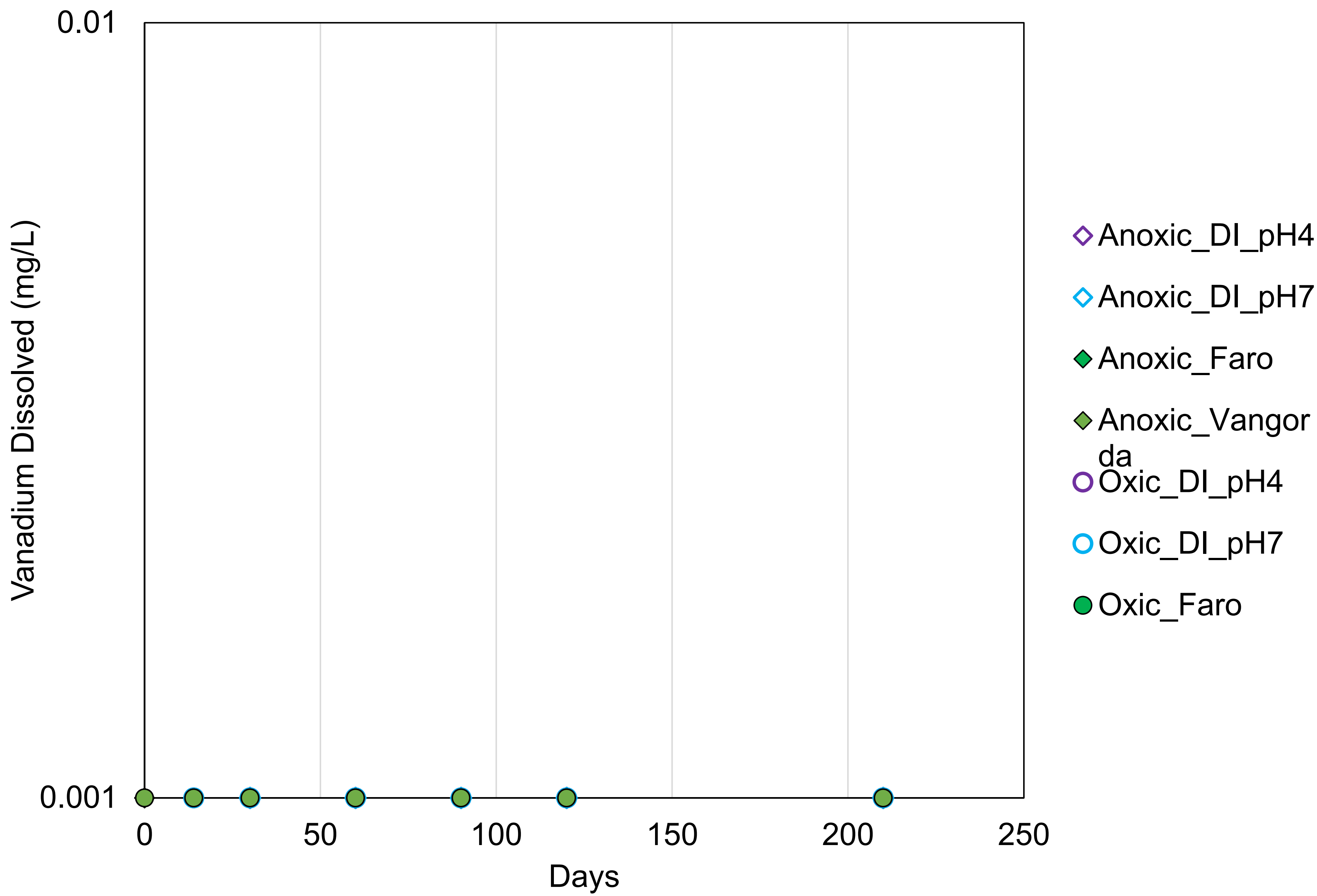
1
0.1
0.01
0.001
0.0001
Selenium Dissolved (mg/L)
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

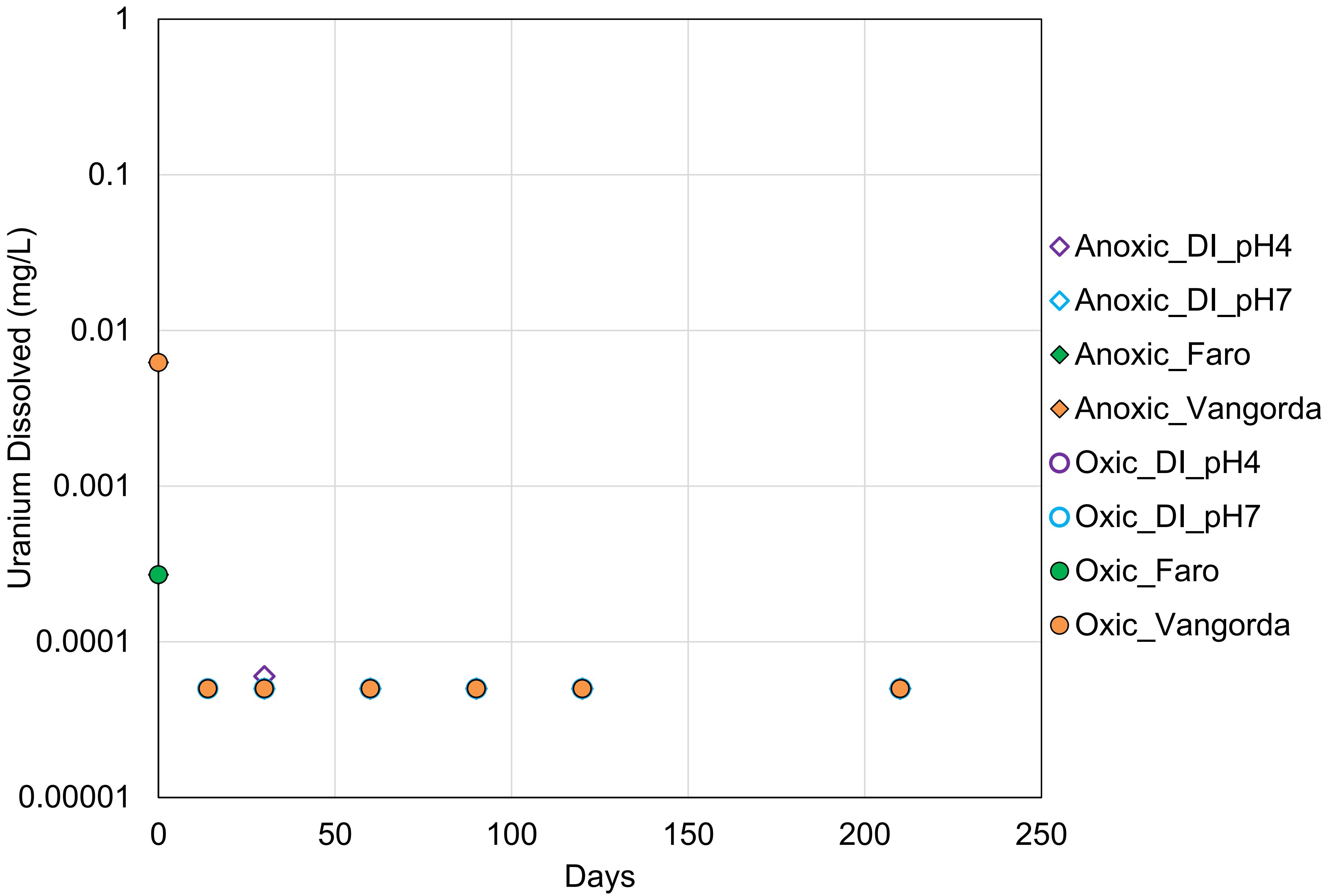

10
1
0.1
Silver Dissolved (mg/L)
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda

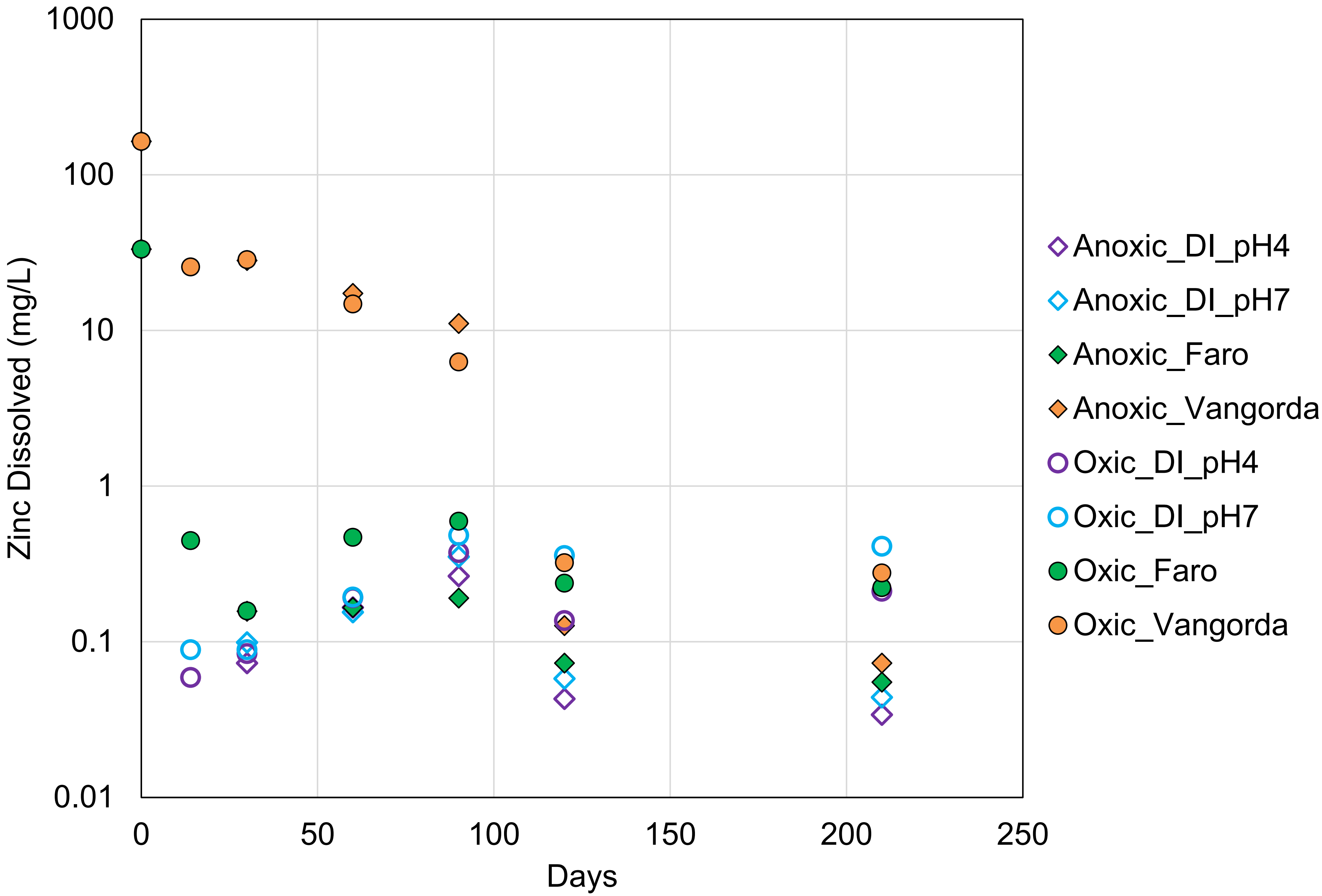

0.1
0.01
0.001
0.0001
0.00001
Silver Dissolved (mg/L)
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda


1
0.1
0.01
0.001
0.0001
Titanium Dissolved (mg/L)
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda


1
0.1
0.01
0.001
0.0001
Thallium Dissolved (mg/L)
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda


0.01
0.001
Vanadium Dissolved (mg/L)
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro


1
0.1
0.01
0.001
0.0001
0.00001
Uranium Dissolved (mg/L)
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda


1000
100
10
1
0.1
0.01
Zinc Dissolved (mg/L)
0
50
100
150
200
250
Days
Anoxic_DI_pH4
Anoxic_DI_pH7
Anoxic_Faro
Anoxic_Vangorda
Oxic_DI_pH4
Oxic_DI_pH7
Oxic_Faro
Oxic_Vangorda